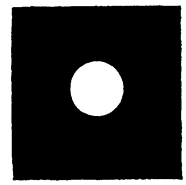
PHOTOGRAPHING IN COLOR



PAUL OUTERBRIDGE

A U. S. CAMERA BOOK • PUBLISHED BY RANDOM HOUSE, INC.

First Edition

A U. S. CAMERA BOOK

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PHOTO-ENGRAVING

THE importance of fine craftsmanship in photo-engraving cannot be overemphasized, as knowledge of most graphic art is generally obtained these days through the medium of reproduction. For example, all the reader will know of the illustrations contained in this book is what he sees in the reproduced plates. As will be noted, most of the reproductions have been made from Carbro prints, and—as mentioned in the chapter on transparencies—whether the original be the most beautiful print imaginable or a transparency, after going through the hands of a good engraver who really knows his business the results possible may be quite indistinguishable. The Walker Engraving Company, who made these illustrations, is on a whole to be congratulated upon their efforts to interpret the original subject matter sympathetically, and upon the fine craftsmanship employed.

PAUL OUTERBRIDGE

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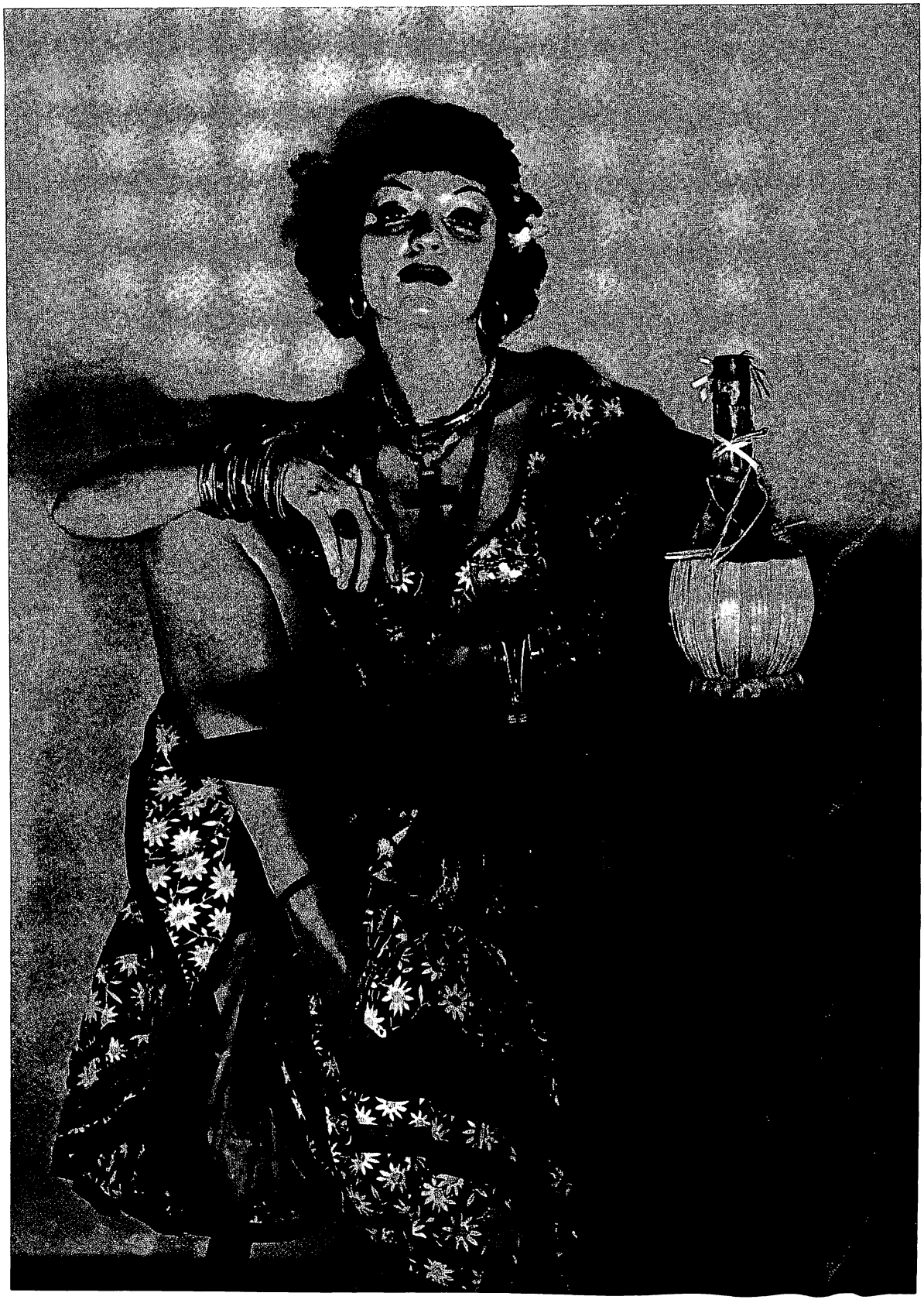

THE PLATES

INTRODUCTION

SO YOU think you'd like to photograph in color! Well, there's no reason why you shouldn't, but you'll have to take certain things into consideration. Color photography in its present state of development, even with the easiest processes known, is not quite as easy as black and white nor is it as fast, and furthermore it costs more.

One very important difference between monochromatic and color photography is this: in black and white you suggest; in color you state. Much can be implied by suggestion, but statement demands certainty—absolute certainty. False rendering of colors in black and white often produces arresting tonal contrasts and dynamic prints, but not so in color, where the slightest falsity of colors is both clearly apparent and wholly unacceptable. Happy accidents do not occur in color —you get nothing for nothing.

The object of this book is to spread before you in panoramic form the various practical processes in popular use in color photography as it exists today. Thus you can look over the whole field, see what is available, estimate what time, effort, and expense is involved in each, and make a choice as to which particular method of operation will best serve your needs. Once having made that choice, everything pertaining to one particular process will be naturally of paramount interest, and the rest of the book pertinent inasmuch as it reflects upon or relates to that process.

If you are interested in obtaining color records in the simplest possible way, and will be content with transparencies, you need go no farther than the first part

of this book. If you are an amateur who wishes to make prints, you will also find the second part helpful. If you are a professional who wants to get into color work, all sections should prove of interest and help. In any event, you must consider this book as only the A B C of your color education, for your own experience will prove to be the best teacher.

Although I have attempted to write this book, especially in some parts, so simply that anyone casually picking it up can get some idea of present day developments in color photography, a good working knowledge of black and white photography is presupposed on the part of the reader.

Each process has its own particular tricks and techniques, and consistent success is a matter of practice. To write a completely comprehensive work on any one of them would necessitate devoting to each at least as much space as is taken up by this whole book. As this is not practicable, I can tell you only some of the pitfalls and limitations, relative merits, and disadvantages of each, give you an idea what to look for, what to avoid, and what sources to consult for additional and more detailed information and instruction.

All color processes are constantly being improved, so much so, that in time I believe it will be possible almost to take color prints out of the back of your camera. Unquestionably, all motion pictures will eventually be in color, and in most of the daily newspapers color will be as common as black and white is today. Black and white will occupy the same place in relation to color as it does today in an art exhibition—one small room off the entrance for the etchings and lithographs.

Color photography is developing at such a furious rate of speed that I am afraid certain of the techniques discussed in this book may be obsolescent, if not obsolete, by the time it comes off the press. To cite but one example: With the routine for color printing with Eastman Wash-Off Relief Film as published in their instruction booklet of that name, the time taken to make a print, as I have found it, is somewhere around three to four hours, whereas at the present moment I know a man who has already changed the technique of this process and, shall we say, improved it so that he is able to produce what appear to be superior prints in less than half of that time. Suppose this man's methods of working the process should shortly come into general use. Then the most carefully detailed current instructions accompanied by the best formulas that are included in this book would no longer be of much value.

All the manufacturers of the materials for the various processes issue dependable instruction and formula books which it is to their interest to keep up to date with the latest developments and changes in their materials. As their materials change, and in whatever way, the manufacturers make compensation by issuing different processing instructions and formulas. However, certain fundamental principles which govern the whole science of color photography will undoubtedly continue to exist but with this modification: their application will become increasingly simplified in various ways.

If I were asked this question, "Will you tell me quickly the three or six most important points to be remembered in order to successfully photograph in color?" I think I should be inclined to answer as follows: (1) complete standardization of procedure, maintained by (2) accuracy and precision, sustained by (3) infinite patience. For those who prefer six rules to three, I might add: (4) exactness of timing and temperatures, (5) taking nothing for granted, but checking, rechecking, and even triple-checking everything, and keeping on doing so, (6) keeping reference notebook records on everything: exposure, lighting, development, and printing.

In these days of multiplicity of photographic gadgetry, too many people believe that ultra-fast lenses and expensive camera equipment insure fine pictures. It is always to be remembered that it is not cameras that take pictures, but the men behind them who do. The camera is only a tool to be mastered like any other tool with which you expect to produce a given result. Nor is it the laboratory equipment that produces the prints, but the intelligence and talent of the men who use it. What is wanted is ideas, a bit more of an aesthetic point of view in a materialistic civilization. To express really vital ideas beautifully through the maze of mechanical and technical media necessary for the production of a good color photographic print is a rare but much to be desired talent, and offers a challenge to those who are now taking up the work.

PART ONE

after Newton made his important discovery, Thomas Young had the idea that the eye contained three sets of nerves, each set responding to three main overlapping regions of the spectrum—red, green, and blue-violet; and that all colors were perceived by the different degrees of stimulation these three sets of nerves received. His theory was elaborated by a man named Helmholtz, and thus came into being what is known as the Young-Helmholtz theory of color perception.

KNOWLEDGE OF COLOR APPLIED TO PHOTOGRAPHY As long ago as seventy-five years, the English scientist, James Clerk Maxwell, demonstrated that the theory of Messrs. Young and Helmholtz could be applied to photography by projecting colored light from three lanterns, containing respectively spectrum red, green, and blue-violet filters; and where the three beams overlapped white was produced. As white light was formed by the superimposition of the three primaries, where only two primaries were combined, their secondary or complementary color was formed—red and green forming yellow, red and blue-violet forming magenta, and green and blue-violet forming blue-green. These colors may be produced in this way only by blending colored light and not by blending pigments on a reflecting surface, as here the previously discussed law of absorption and reflection necessitates the use of the complementary colors of light, which are the three printing colors used today.

If you have ever dabbled with crayons or water colors, you know that red and blue make purple; that the more blue used the bluer or colder the purple, and the more red, the warmer or redder the purple; that if you are painting trees or grass, blue and yellow make green, and by adding red to the green you deepen the color. Flesh tones, for example, are composed mostly of red and yellow—slightly more yellow than red, and a smaller amount of blue to keep them from being too bright orange and give modelling. To arrive quickly at an idea of how the three primaries produce different colors, look at the "Color Chart" in the Appendix.

If one hundred per cent of red, green, and blue-violet light is combined, white is produced. If one hundred per cent of each of the complementary colors of light, which are the primary colors of printing—blue-green, magenta, and yellow pigment or dye—is combined in equal proportions on a light reflecting surface such as paper, black results. If fifty per cent of each of these colors is combined, a half-tone gray is produced; and similar combinations in smaller quantities produce lighter grays, until where no colors are combined white is arrived at. Therefore gray—neither bluish, reddish, nor yellowish gray, but a truly neutral gray—is composed of exactly equal quantities of the three pigment primary colors: magenta, yellow, and blue-green.

Due to this unalterable fact, a means is provided for checking the exposure, development, contrast, and color balance of the materials used for the production of color photographs. If a gray tone scale is included in a color composition, and each of the gradations in this scale of grays matches in each of a set of three-color

PART ONE

1

COLOR AND PHOTOGRAPHY

WHAT IS COLOR? No object of itself alone has color. We know that even the most brightly colored object, if taken into total darkness, loses its color. Therefore, if an object is dependent upon light for color, color must be a property of light—and so it is. White light is a combination of all the colors of the rainbow. Sir Isaac Newton demonstrated this fact nearly three hundred years ago. If you have ever seen daylight passing through a prism, you have noticed the band of color it makes—like a rainbow. This is the spectrum—white light divided into its component parts.

All objects absorb and reflect various proportions of the spectrum. Those that reflect all the light rays are said to be white, and those that absorb all the light rays are said to be black. If objects or surfaces reflect half of all of the light rays and absorb the other half, they are gray—a neutral half-tone gray. If an object or surface reflects certain components of the white light rays and absorbs others, then it is colored. If, for example, it absorbs the blue-green and yellow rays of the spectrum and reflects the red rays, it appears to the eye as a red object. If it reflects the yellow rays as well as the red, it will appear orange in color—for as you probably know red and yellow combined make orange. When you look at a colored object, remember that the color you see is the color or colors it reflects, for all the other colors that it might have been have been absorbed by it.

VISUAL PERCEPTION OF COLOR Nearly a hundred and fifty years

after Newton made his important discovery, Thomas Young had the idea that the eye contained three sets of nerves, each set responding to three main overlapping regions of the spectrum—red, green, and blue-violet; and that all colors were perceived by the different degrees of stimulation these three sets of nerves received. His theory was elaborated by a man named Helmholtz, and thus came into being what is known as the Young-Helmholtz theory of color perception.

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separation negatives and the positives made from these—so that when recombined to form a print the original scale of grays is reproduced in its original neutral character—it therefore must of necessity follow that all the other colors photographed in this composition must be correct. In other words, any of the colors in nature can be reproduced by mixing together in correct proportion red, green, and blue-violet light, or blue-green, magenta, and yellow pigments or dyes on a light reflecting surface such as paper to produce a print, and the principles of all three-color or natural color photography are based on this fact.

COLOR FILTERS If you wished to reproduce a given color, what would you have to do? You would first have to find out exactly how much of each of the primary colors is contained in that particular color. How could this be done? By making use of scientific devices known as filters, which break down the color you wish to photograph into the various amounts of the primary colors of which it is composed. The three filters used in color photography, commonly known as tri-color separation filters, are red, green, and blue-violet. They sort out in correct proportion various amounts of blue, red, and yellow contained in a person's face, for example, in a landscape, or in whatever you might wish to photograph.

HOW FILTERS SORT OUT COLORS On account of the negative-positive basic principle of all photography, the filters register the three primary colors in minus or negative form on the photographic plates, from which they are printed in plus or positive form to produce a print. As you probably know, a white object will impress the plate strongly, thereby making that part of the plate opaque, and dark objects will appear as thin or transparent portions of the negative. When it comes to printing, the opaque parts of the negative will print light and the thin or transparent parts will print dark.

Now let us try to visualize this as applied to color. When you photograph red and blue blocks, like a child's building blocks, through the red filter, which passes only red light, the red block, reflecting red, will pass a lot of red light onto the photographic plate, thereby forming a heavy deposit in this area. The blue block, or object which reflects blue light, will be incapable of reflecting much light through the red filter—only enough to produce the modelling or shadow side of the block. Therefore it will cause only a relatively faint impression to be made on the plate here. When this negative made through the red filter is printed in its complementary or minus color, blue-green, the blue block—which is represented by the thin portion of the negative—will print strongly; whereas the red block, being an opaque deposit, will print quite faintly. Now when it comes to the green filter negative, which records blue and yellow light but not red, the blue object will register as a heavy deposit or opaque area in the negative, and a red object will register quite thin. Therefore, when the negative made through the green filter is printed in its complementary color, magenta, the blue object will print very lightly, whereas the red one will print quite strongly. This will occur

similarly in proportion to the amount of yellow in the red block in the blue filter negative, which prints the yellow. So by this means the amounts of color in a subject are reproduced in the negatives in their correct proportions in black and white negative tones which, when printed, represent the colors in the subject in black and white positive tones. Now, if these black and white degrees of contrast or tones are converted into color, there will be color present in proportion to the depth of the black and white tones, and when these three primary colored images are combined in register, a color picture reproducing correctly all the colors of the original subject photographed is created.

COLOR PROCESSES

Basically, color processes divide into two main types: additive and subtractive. The additive process produces the transparencies; the subtractive process, the prints on paper.

ADDITIVE PROCESS The additive process produces a reproduction of the subject photographed by adding together red, green, and blue-violet light in correct proportion to reproduce each and all the colors contained in the subject. You will remember that where blue and green are combined blue-green is formed; where red and blue, magenta; green and red, yellow. This blending may be accomplished on a single plate or film by combining fine lines or dots of the primary colors, either regularly or irregularly, to form a screen of tiny color filters through which the subject is photographed on a panchromatic emulsion which is coated on the glass plate or film-stock base. At present the most popular form of a true additive process would seem to be Dufaycolor, and the reason why it has apparently superseded various other transparency processes is probably because it is on film instead of glass plates and therefore more convenient and transportable.

In the additive processes the exposure and final color result are contained and combined in one plate or film. All you have to do is load it in your camera and follow a few definite instructions for exposing it. The filters and the color are in the film itself, and by following the simple directions in the manufacturer's instruction booklet, in a short time you will in all probability be able to turn out satisfactory color pictures.

The additive processes are capable of producing quite good results from which a photo-engraver can make satisfactory plates for reproduction in a magazine or book; however, if reproductions are not intended, you will always have to hold the film up to the light to see your color picture unless you want to go to the trouble of making a print from it. In all probability, making transparencies, especially in miniature camera size, with Dufaycolor or Kodachrome is by far the simplest, quickest, and cheapest way to get results in color photography today.

DUFAYCOLOR With Dufaycolor the taking screen is coated on the base of

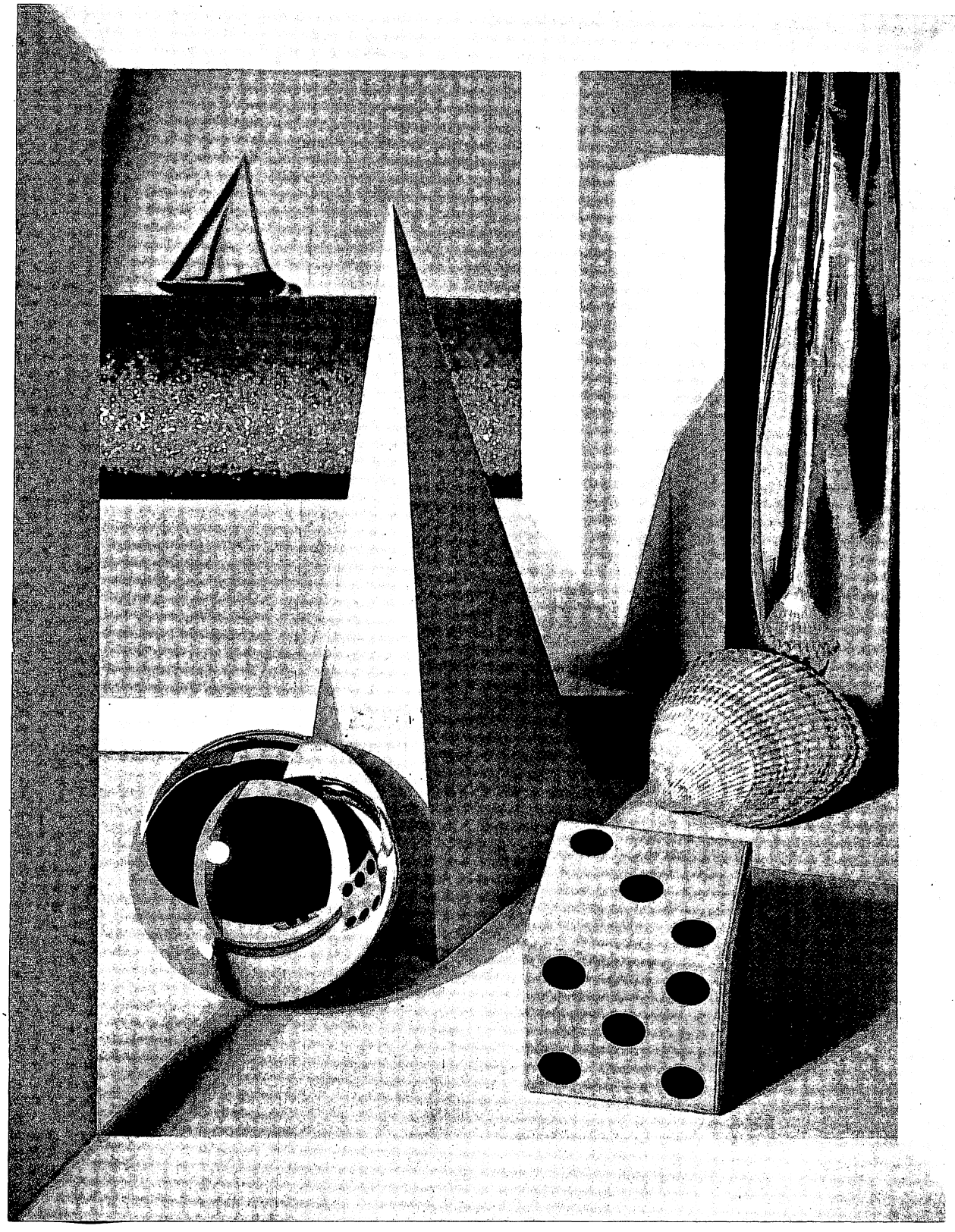
the film-stock under the panchromatic emulsion, and exposure is made through the back of the film so that the light reaching the emulsion is appropriately filtered before reaching it. After development the negative image is bleached out and redeveloped into a positive which, after due processing, may be viewed by transmitted light and reproduces the original subject photographed in its original colors.

KODACHROME Kodachrome produces transparencies which are, however, a product of the subtractive process instead of the additive. With Kodachrome there is no screen; three layers of emulsion are coated over one another on a single film-stock base. Each one of these emulsions is sensitized so as to record only that certain portion of the spectrum transmitted by one of the tricolor filters. After the film is developed to an ordinary black and white negative by a system of reversal to a positive, bleaching out the silver image, and redeveloping these three emulsions in primary red, yellow, and blue—with what are known as dye-couplers (a dye-coupler is a form of developer which, as it develops the image, colors it at the same time), these three dyed images combine to form a very faithful reproduction of the subject photographed. Kodachrome is constantly increasing in popularity although possessed of one drawback—which may be rectified in time and to which Dufaycolor is not subject—you cannot develop it yourself; but must send it back to the Eastman Kodak Company for processing.

Both Dufaycolor and Kodachrome are capable of giving excellent color reproduction if the lighting employed is exactly of the color temperature to which they have been arbitrarily balanced in manufacture, and also if the taking exposure is about ninety per cent correct, for with these processes very little latitude in exposure is permissible if the best color results are to be expected.

SUBTRACTIVE OR PRINTING PROCESS The subtractive processes produce the prints, and for all prints separation negatives will always be necessary. A question that has often been asked me by people looking at a color print for the first time is, "How do you get the color in it?" So here in brief outline is how it is done. Three panchromatic plates or films are exposed behind three color filters. One of these contains a black and white rendering in negative form of all the blue in the subject, another of all the red, and a third of all the yellow. These plates are developed like any other negatives except with much greater care, and this set of what are known as tricolor separation negatives is the starting point for the carrying out of all the three printing processes in popular current use. When color positives or prints are made from these separation negatives and combined on paper, a color photograph results. A short description of each of the three current printing processes follows.

THE CHROMATONE PROCESS Three prints are made, usually by enlargement, from three separation negatives on special Chromatone Print Paper which is made of a collodion stripping film containing a photographic emulsion,



coated on a paper base. After development of these three black and white enlargements, the wet paper base detaches from the collodion film which bears the image. These three thin films are then placed in bleaching baths, where the black and white image disappears. Then they are placed in toning baths wherein the image reappears, only each image in one of the three primary printing colors instead of in black and white. When these three thin films bearing colored images are assembled in register on paper, the result is a color print usually, but not necessarily, with a high glossy surface due to the collodion film.

THE WASH-OFF RELIEF PROCESS The Wash-Off Relief process produces color prints as follows: Enlargements are made from the three separation negatives upon sheets of special Wash-Off Relief Film. After development to a black and white, this print image is bleached out and tanned, rendering it insoluble, and the excess gelatin washed off, leaving the image in faint shadowy outline in relief, or raised; or, for want of a clearer example, like a rubber stamp. Just as the rubber stamp has to pick up ink before it can make an impression, so the Wash-Off Relief Films have to be soaked in dye baths to pick up color, from which they print down on paper, one over the other in register, three primary-colored images of the subject photographed. When these images are combined they reproduce all the different colors of the subject photographed, and there you have your Wash-Off Relief print. The relief films, or matrices as they are called, are capable of being used over and over for making a number of color prints as they are, in a sense, very similar to printing plates.

CARBRO PROCESS The Carbro process makes use of the same set of three negatives in the same enlarger this way: Prints are made from them on special bromide paper and after being developed, fixed, and washed, they are squeegeed into contact with tricolor pigmented paper which has been sensitized in a bleach-sensitizing bath. The image is bleached off the bromide print and transferred from it to the special Carbro pigment paper which is eventually squeegeed onto sheets of celluloid, where it is developed with hot water which washes away all the pigment not needed and leaves a perfect reproduction of the original black and white image in colored gelatin about a ten thousandth of an inch thick. These tricolor gelatin images are transferred in register, one by one, onto a paper base, and combined to form a rich, matt surface Carbro print. With Carbro, exact duplication of prints is very difficult. Note: Although enlargement has been referred to constantly, all these processes lend themselves equally well to contact printing.

There, in a nutshell, are the underlying principles of the commercially used color processes for print making. Each process has its distinct advantages, disadvantages, and techniques; but the most time-consuming, the most temperamental, and the process capable of rendering the most beautiful results, in the opinion of most color workers, is Carbro.

METHODS OF OBTAINING PRINTS You noted that three separation negatives are always needed for making prints. They may be made from the subject one after another in an ordinary camera, or all together in a special single-exposure color camera; or they may be made from a Dufaycolor or Kodachrome film. With the latter method you will have a chance to see your picture in color before starting to make the print, but the former method is really the best one for print making because colors are separated directly on the subject itself. With the other methods, the colors are separated from a picture of the subject; in other words, the separation is one step removed. No matter how carefully the work is done, each additional processing step introduces variations and the possibility of error in the reproduction of tonal values.

If you do not want to be bothered or do not want to spend the money for the equipment necessary for making prints, you can have them made for you either by the Eastman Kodak Company from your Kodachromes, or by the Dufaycolor Company from your Dufays, or by one of various new print services, such as Triak, that are springing up all over and charging very reasonable prices for their work. Consulting a good photographic dealer, or the sources of supply of materials for color photography, will provide information as to where you can have prints made. However, regarding most print services, as the corner drugstore type of black and white prints was never satisfactory for professional use or for the serious amateur, there is no reason to suppose that quantity production of color prints, which are a lot more difficult to make, will be any better. So if you are finicky and particular as to quality, if you have the temperament of a craftsman and want to arrive at really fine color prints, and if you then have the time and money to spend to achieve them, you had better get right down to business and make your own. After all, color photography may be just as amusing and entertaining a way of spending time and money as any other hobby which takes quite a bit of both.

If transparencies will satisfy you, you will find photographing in color a lot cheaper and easier, for there is no really very cheap and easy way of making prints on paper, especially consistently; and when you go into print making everything becomes more complicated, laborious, and expensive. After you have spent quite a bit of time and quite a little money and wasted quite a lot of material, if you persevere you will gradually begin to see results emerging from the fog of your first confusion; you will have picked up pointers here and there and a color vocabulary from contact with the work and color workers, and the sources of supply for the materials. If you decide on Carbro as a process you will have to be prepared to lay out the money necessary to obtain consistently good results. I know, for I've been through the mill; and, furthermore, although I have made hundreds of Carbro prints—good ones too, for they have to be or you don't sell them—still every so often, as with probably everyone else who produces Carbros, I run into trouble in turning out a good print.

You will be able to get a rough idea of costs in the Appendix, together with the

routine of operations necessary for the different processes and their approximate times.

Upon your deciding on just what you want to photograph in color most, just how much money you can spend, and your selection of a process capable of producing the results you want, will depend the type of camera and equipment you will need. We will therefore go into the matter of cameras in the next chapter.

2

CAMERAS AND CAMERA EQUIPMENT

CHOICE OF CAMERA Practically any kind of camera equipped with a high grade anastigmatic lens (most anastigmats are corrected for color) may be used for color photography if, as a final result, the operator will be satisfied with a transparency. No one camera will photograph everything equally well in black and white, and this is just as true in color photography, if not more so. Your choice of a camera, financial limitations excluded, depends largely upon what you wish to photograph. The whole problem of the selection of a camera breaks down to this: do you want to photograph action and animate subjects, or still life and inanimate subjects? Will you be content with transparencies, or must you have prints on paper?

YOUR PRESENT CAMERA AND ITS APPLICATION TO COLOR Let us say that you have a post card size roll film camera, and you would like to make some color pictures. You can go down to your photographic supply dealer, buy a roll of Dufaycolor film, and go right out and take pictures—even of a moving object. Because the speed of color films is much slower than that of black and white film (somewhere between Weston 3 and 12), unless you have a fairly rapid lens on your camera (at least F/6.3) and the sunlight is of the brightest, you will be liable to underexpose if you try to stop motion. You could not use this camera for Kodachrome, for Kodachrome is not available at present in various sizes of roll film—only in 35 mm. and 16 mm. film suitable for motion picture cameras

and so-called candid cameras such as the Bantam, Leica, or Contax, or in cut sheets 3¼ x 4¼, 4 x 5, 5 x 7, and 8 x 10 inches, which of course could not be used in a roll film camera unless you had a plate back attachment.

MINIATURE CAMERAS If your principal interest is in photographing action subjects, a miniature camera such as the Retina, the Contax, or the Leica would probably be the best one available for this purpose today. This is because these smaller cameras have smaller, shorter focus, and faster lenses, which permit of greater speed with good depth of focus at much larger lens apertures. Of course, while the camera you have may not give you satisfactory results for action, it will probably do very well for still life. If you want prints on paper, as has been noted, these will always require three color separation negatives. True, they may be made later from your Dufay or Kodachrome originals, but such procedure rarely gives as fine a result as when the separation negatives are made directly on the subject. Separating transparencies is a lengthy and somewhat complicated business, but so is the making of all color prints on paper, relatively speaking.

THE VIEW CAMERA The simplest and still the most satisfactory camera for general use with inanimate subjects is the view camera. Nine-tenths of professional work in photography has for a long time been done with this sort of camera. As you probably know, it consists merely of a box with a lens at one end and a means of attaching a plate at the other. The walls of this box are an expanding and contracting bellows to permit moving the lens closer or farther away from the plate—in other words, focusing. On account of its rising and falling front, back swings, large lens board, and long bellows extension, this camera is about the best for all color separation work in which movement or possible movement is not a factor. A great many of the illustrations in this book were made with a view camera.

As 5 x 7 inches is a good size on which to standardize for making separation negatives, because it is quite large enough as a basis for commercial size enlargement and because practically no one-shot cameras or enlargers are made bigger, either a 5 x 7 inch view camera, or better an 8 x 10 inch view camera with a 5 x 7 inch back—which will permit of greater bellows extension and flexibility—is just about the right sort of equipment for the purpose. Of course, the 4 x 5, and even the 3¼ x 4¼ inch view cameras are perfectly satisfactory for a lesser degree of enlargement; it depends upon the size desired for the final print. Obviously, the smaller sizes will cost less money to operate all the way along the line. Most professional color photography involving the delivery of prints is made on 5 x 7 inch plates, not film. Of course, with a view camera a tripod must always be used.

OPERATION OF VIEW CAMERA FOR COLOR WORK When a view camera is used for color, a filter holder and set of tricolor separation filters are attached to the lens. This pertains only to separations for making prints, for you can use a view camera for color just as for black and white work, even including

action shots, if you are using Kodachrome or Dufaycolor film in it. The filter holder which is attached to the lens is so made as to permit of sliding the three color filters into place before the lens, one after another, simultaneously with changing the plates at the back of the camera. (See Fig. 2, p. 178 and "Filters," p. 23.)

SUBJECTS FOR WHICH A VIEW CAMERA IS SUITABLE Here is a list of subjects for which the view camera is suitable: (1) Still life (not including flowers in hot artificial light, which may cause them to move during or between the three successive exposures, thereby making subsequent registration of the print impossible); (2) Interiors and exteriors in which there is no possibility of movement in foliage, grass, or flowers (movement that is so slight that it can scarcely be detected by the eye will make it impossible to obtain a good color print from the subject later, and you might as well realize immediately that there is hardly any summer landscape scene that is devoid of some slight movement); (3) Portraits in which the subject is so carefully and completely braced as to preclude the slightest movement during and between the three exposures—not even breathing. This really means that the subject must hold his or her breath, usually for a matter of some fifteen seconds at least, and of course the photographer will need an assistant to change the filters while he changes the plates and makes the exposures. If you want to try something really nerve-wracking, you might try this out; and, whereas the possibility of stretching into register in the Carbro process will permit of a fairly good final print from this sort of preliminary technique, you will find it much more difficult to make a Wash-Off Relief or a Chromatone print from negatives made in this manner.

Before I had a one-shot camera I made a few quite passable color photographs this way, but once having used a one-shot I would never want to go back to the old way. Furthermore, one-shot cameras have lately become much better, cheaper, and more easily available. (Note: All other cameras, including roll film and the reflecting types such as the Graflex, share the same limitations and technique of procedure for the making of separation negatives, except that plates in a Graflex magazine may be changed faster than plate holders in a view camera. In using Dufaycolor film or Kodachrome in a view camera, relatively the same technique is employed as that for black and white, except as regards lighting, which is always different for color.)

THE SLIDING BACK The sliding back is an attachment usually used in connection with the view camera, but it may also be attached to the back of a Graflex or other reflecting type camera. It is a frame containing tricolor filters of the size of the plates used. These plates fit side by side into a single long plate holder in back of the filters. When the single dark slide of this long plate holder is drawn, all three plates are exposed, one after another, back of their respective filters. The light-trapped frame, or movable carriage, with the plate holder back

of it, slides across the taking aperture at the back of the camera; it may be pushed across by hand or it may fall by gravity or be drawn across by a tension spring. With the latter two methods of moving it, it is important to have some sort of air-cushion to prevent jarring the camera as each plate falls or is drawn into place. Jarring and vibration during exposure are to be avoided at all costs; and, for this reason, a camera equipped with a sliding back should be bolted onto a heavy aluminum plate with rods or struts for bracing. Furthermore, it should be mounted on the heaviest and most rigid tripod obtainable, such as a heavy motion picture camera tripod.

The sliding back saves the time of putting in the three separate plate holders in succession, drawing, and replacing the slides of each, as well as changing the filters. It may be made more nearly automatic by attaching a long release from the shutter to its mechanism, setting the shutter on bulb, whereby by pressing on a single hand release the shutter is opened on the first exposure made through the red filter, held open for the required number of seconds; and when the pressure on the release is relaxed the shutter closes and the spring or gravity draws the next plate into position before the exposing aperture. This occurs three times.

Further refinement of the sliding back has been made in England by a system of timing dials and dashpots. A single pressure on the cable release is sufficient to make all three exposures, for the back, once released, slides across automatically measuring out times for the different exposures which were originally set on the dials. With this completely automatic sliding back, sets of separations may be made in as little as two seconds.

The sliding back preceded the one-shot camera, and up until the time that one-shots were brought to the degree of refinement and perfection found in them today, it was by far the fastest and best way to make color pictures. It is still a good way for certain subjects. For one thing, much shorter focus lenses may be used on the sliding back than may be used on any one-shot camera, due to the latter's necessary interior mirror construction. Furthermore, the color separation is as perfect as that obtainable by changing plates behind gelatin filters in a view camera. Very fine pictures can and have been made with a sliding back, and although its operation in certain respects is somewhat more arduous than that of a one-shot camera, in other respects it is easier, as subsequent development of the plates is apt to be somewhat simpler and color balance somewhat superior to that sometimes provided by one-shot cameras.

You may either make one of these yourself and get the necessary filters from the Eastman Kodak Company, or buy one ready-made. I think the best ones come from England; of course they are better made entirely out of metal than of wood, as metal will maintain better mechanical alignment. A simple form can be purchased for around $100, and, in the hands of an experienced operator, for subject material within its capacity it will produce just as good results as those obtainable with any one-shot camera. It will be readily realized that the sliding back will

not permit of any instantaneous or flashlight work, which can be done only with a single exposure camera. To gain a clearer picture of the sliding back, see Fig. 3, p. 178.

SUBJECTS FOR WHICH A SLIDING BACK CAMERA IS SUITABLE Although much faster exposure technique is possible with a sliding back than with a view camera, it must be remembered that you are still making three separate successive exposures, the images of which must later register perfectly, one over another: every blade of grass, every thread of a fabric, every eyelash. Stopping action is impossible, but even standing figures, if skilfully and invisibly braced, are within its province. In short, you can handle all the subjects with a sliding back that you can with a view camera, and even more.

DUPAC AND TRI-PAC The Defender Company manufactures a Dupac composed of two films, emulsion to emulsion, which produces a semblance of natural colors due to one's being sensitized to blue-green, and the other to orange-red. This is a compromise, an arbitrary cutting of the spectrum similar to the original Technicolor process of the motion pictures. Of course only a very rough approximation of really natural colors may be had from trying to split the spectrum into two main divisions capable of suggesting, although not reproducing, all of its colors. However, some quite pleasing results may be obtained this way if the colors photographed happen to fall within the range or capabilities of this method of color separation.

Defender also makes a Tri-Pac, which gives much better color separation—but with somewhat soft, diffused results. The light has to pass through the first film, which is sharp, to the second film, which is less sharp due to the diffusion produced by passing through the first one. By the time the light has passed through the first two films to the third film (the yellow printer negative), the image is quite soft indeed; and while pleasing, somewhat soft focus effects may be obtained in this way, this method of recording color is out of the question when really sharp precision results are desired. These packs are exposed in more or less the same way as single black and white film, except that they are much slower, having a Weston rating of 1.5 in daylight and 3 in tungsten light.

Of course, for good results the lighting should be of the color temperature to which the films have been balanced, and again the general arrangement of lighting must necessarily be suitable for color rather than for black and white. These Dupacs and Tri-Pacs have no color in or of themselves, but merely provide another method of making sets of color separation negatives which must be kept in balance in development like any other color separation negatives used for producing a color print. They may be used in ordinary cameras capable of taking plate holders, and provide the only means of making simultaneous color separations directly from the subject without going to the expense of buying a special one-shot

color camera, or at least a color back for a view camera. Flashlight and action shots are possible with Dupac and Tri-Pac.

ONE-SHOT CAMERAS One-shot cameras divide into two types: single-mirror and double-mirror. There are several makes of both on the market, but, as the plan of all of them is more or less the same, three examples should suffice to acquaint you with the general idea of how they all work: all make use of semi-transparent mirrors—mirrors that have been partially silvered so that they have the capacity to reflect a calculated percentage of the light and transmit another calculated percentage.

THE SINGLE-MIRROR ONE-SHOT CAMERA The single-mirror camera, of which the Lerochrome camera is a good example, is a further development of the pack idea. In it part of the light from the lens passes through the reflecting-transmitting mirror to a single film of what is known as Defender Tri-Color Film Combination, while the other part, minus, of course, the loss through absorption, is reflected from the mirror to a bipack. One element of this bipack consists of a color-blind emulsion coated yellow, which is placed emulsion to emulsion with a high green sensitive orthochromatic emulsion in one plate holder at the side of the camera. The color-blind coating records in negative form the yellow in the subject photographed, and the light, passing through its yellow dye, records the red on the high green sensitive ortho emulsion. In the other plate holder for the blue record, the light passes through the single mirror, which is made of optically flat Jena glass treated with uranium, a radioactive metal, and colored red so that only red light reaches the single red-sensitive panchromatic film in the back of the camera.

These single-mirror cameras make use of Finlay-type, pressure plate holders in which the films are pressed tightly against special quality, perfectly flat glass by a spring back similar to that on a printing frame.

Although single-mirror cameras will not render the weave of fabrics or fine lettering, for example, as sharp as double-mirror cameras will, they have certain advantages which are not to be overlooked: they cost less; they are easier to operate; only two plate holders are used instead of three; focusing is done on a clear, colorless, ground glass instead of through a green filter; and the camera may be used for straight black and white work. I am somewhat inclined to believe that the color separation obtained in this manner may be even better than that obtained from double-mirror cameras, due to the fact that the films are dyed at the point of separation. As the light has to pass through the front film in the bipack combination to reach the rear film, which is the red printer, the latter is very slightly diffused, which tends to give a charming pictorial quality especially in portraiture and certain landscape work. If it eventually becomes possible to laminate these two films together into tighter contact, perhaps the single-mirror camera will then be capable of producing almost as sharp results as the double-mirror does at pres-

ent. Of course, these two films would have to be so joined as to come apart in the developer. However, I have always disagreed with the point of view that all photographs must be wiry sharp and that sharpness is the criterion of good photography. It would seem to me that various subjects lend themselves to different treatments. It all depends upon what is photographed.

Fig. 5, p. 179 will serve to show how single-mirror cameras split the single beam of light from the lens.

THE CURTIS COLOR BACK This is an attachment applicable to the back of a view camera which will, relatively speaking, transform it into a one-shot camera. It consists of a box capable of accommodating two plate holders of a type similar to those used in the single-mirror one-shot camera. Within this box is a single mirror which splits the beam of light two ways to a bipack and to a single film element of Defender Tri-Color Film Combination, as is done in the single-mirror camera just described. Results similar to those obtainable with a single-mirror camera are possible with this equipment, which combines the advantages of the view camera, such as rising and falling front and swing movements, with low cost.

THE DOUBLE-MIRROR ONE-SHOT CAMERA The one-shot camera provides the means of exposing all three glass plate or film negatives simultaneously; but, whereas it has solved this problem and that of the subsequent perfect registration of the negatives and finally even that of obtaining good color separation, it has not solved the problem of speed. One-shot cameras, as they are known today, are pretty slow, especially if good color separation is of paramount importance.

Let us take the Devin as an example. This is as good a single-exposure color camera as there is made today, and yet it has a Weston speed of only 5. Contrast this with the new fast emulsions being used for black and white, such as Eastman Super-XX with its Weston speed of 120, or, conservatively speaking, 100. You will see that if a subject demands stopping down your lens to F/11, you could make a black and white exposure with Eastman Super-XX in a hundredth of a second, whereas with a one-shot camera, for obvious reasons, the exposure needed would be about one-fifth of a second. The Daylight Special model of the Lerochrome has raised the Weston speed to 12, but even with this great advance the exposure would be only one-twelfth. Just as the one-shot camera is the only device for making three glass plate negatives with flashlight, flash is the only way in which one can arrive at any great speed with the one-shot camera. Sunlight, even very bright sunlight, does not provide enough light to get any degree of speed with a 5 x 7 inch, one-shot camera equipped with a 12 inch lens, for a lens of this focal length demands considerable stopping down to insure a tolerable depth of focus in the finished picture. As I said before, the very nature of the construction of a one-shot camera does not permit of the use of shorter focus lenses, which pro-

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vide greater depth at a larger aperture. Of course, from the point of view of good drawing or perspective, we have no quarrel with the longer focus lens.

Now that we have found that the one-shot camera, although having the ability to make all three exposures at one and the same time, is slow, and that this is due to its construction which is more or less the same in all the better types, let us see what makes a one-shot camera so slow. Just as in a line, the slowest man always sets the pace, so the slowest filter—that is, the blue filter, which requires the greatest exposure multiplying factor—sets the speed of the one-shot camera. This difficulty is further increased by the fact that the mirrors absorb a certain amount of light.

I believe the Devin and Lerochrome are two of the best of the double-mirror cameras on the market today; and as all double-mirror one-shot cameras are based more or less on the same principles of construction, the diagrams in Fig. 4 and Fig. 5, p. 179 should acquaint you with what they look like and how they work.

Both these cameras make use of silvered pellicle mirrors, which are a fine membranes—something like the thin cellophane wrapping on a pack of cigarettes—which are stretched over optically flat frames. It was not until pellicle mirrors came into use with double-mirror one-shot cameras that the matter of perfect registration of the three images was solved. With glass mirrors the thickness of the glass caused an error of refraction due to its bending the light rays, and the images were out of register in proportion to the glass' thickness. Due to the mirror's being on a forty-five degree angle, the image was smaller. Slanting the top plate and paralleling it with the mirror as much as possible helped maintain the size of the image.

LENSES The careful selection of lenses for use in color work is much more important than for black and white, for the lenses must not only be corrected for spherical aberration, but also well corrected for chromatic (color) aberration.

For purposes of registration, it is obviously important that the three images made through the three color separation filters be of identical size and sharpness. This does not occur with most lenses, even with many of the better color-corrected anastigmats. They either produce one image slightly softer than the other two—as the color rays forming this image come into focus in a slightly different plane from that of the others—or if compensation is made for this by moving the plate with the soft image farther away from the lens to sharpen it up, a larger image is produced which will not register perfectly with the other two. What happens is that one of the images comes into focus before the two others. For this reason, if one intends doing professional color work—especially making prints or sending separation negatives to an engraver from which to make plates—the choice of a lens for the purpose is of considerable importance. This matter of lenses being color-corrected also applies to Kodachrome if you want to arrive at really good results.

From among the better anastigmats the Goerz Dagor, Schneider Xenar, Carl

Zeiss Tessar and Protar, Hugo Meyer Aristostigmat, and the Eastman Kodak Company's Ektar may be selected as suitable for color photography. There is also the special Lerochrome Wollensak. However, when it comes right down to it, the very best type of lens for color work is the apochromat. Carl Zeiss, Goerz, and Hugo Meyer all make apochromats, but they come in only a limited number of focal lengths. For one thing they cut very sharp, and for another they bring all the color rays to focus on the same plane, but here comes the sad news: their maximum speed is F/9. I have not found this as much a difficulty from the taking as from the focusing standpoint, for from my own experience it is very seldom that one can take any sort of decent picture at a much larger aperture than this anyway. Focusing through the green filter of a one-shot camera equipped with an F/9 lens is a bit trying unless one is using quite a bit of artificial light or plenty of bright sunlight on the subject. As a matter of fact, even though it is a nuisance, I usually take out the green filter, substituting a clear glass of identical thickness for focusing so I can see what I am doing. Of course, you do not have this sort of trouble with Kodachrome or Dufay, or with separation negatives made in a view camera, or even in a single-mirror one-shot camera.

FAST LENSES In passing, let me make one observation about fast lenses. You will note from the data accompanying the pictures in photographic magazines and annuals that, although they are very often made with an F/4.5 this or that make of lens, practically invariably the exposure was made at F/8 or F/11 or below. So there in brief is your answer to the importance of the F/4.5 and faster lenses, except in their application to miniature (candid) cameras wherein you can get some use out of those larger diaphragm openings.

LENS FOR INTERIORS For interiors I have found that the Carl Zeiss wide-angle Protar is quite satisfactory, and again, due to its maximum aperture of F/18, unless you have considerable light on your subject, focusing entails certain difficulties.

LENSES FOR ENLARGING You will certainly need a color-corrected lens on your enlarger if you want to make enlarged separation negatives from Dufay or Kodachrome originals, for here again you are dealing directly with color.

LENSES FOR TRANSPARENCIES By and large, the tolerances might be said to be greater with the screened film processes than where three separate negatives are made with the intention of eventually combining them into one color print, especially a Wash-Off Relief or a Chromatone which do not permit of the same latitude in stretching or bending into register provided by the Carbro process.

LENS HOODS All photographing should be done with a good lens hood, and this is especially true of color. Among advanced color workers two of the most popular lens hoods are the German Wörsching and the American Holly-

wood, but in an emergency quite satisfactory results can be obtained with just a piece of black felt fastened around the lens with an elastic band, or even some black paper such as that used in wrapping photographic plates. Be sure to use some kind of lens hood.

EXPOSURE METER Do not attempt to do color work without a good exposure meter. The best, the most convenient, and the most popular among color workers, seems to be the photo-electric cell type like the Weston or General Electric meter. Color allows very little latitude in exposure, especially with Dufay and Kodachrome, which really should be about 90 per cent correct. Otherwise, instead of merely getting under- or overexposure out of which you can pull a black and white print by using contrasty or soft paper, you will distort or throw all the colors out of balance. You see, in color print work—with the exception of Chromatone—you are limited to the contrast of a single paper or film. Therefore you must make your negatives so that their contrast will be in as nearly perfect accord as possible with the latitude of your printing paper or film.

The Weston Meter is a fine precision instrument that does a good job, and, like any other precision instrument, it must not be abused and should be treated with due care if you want the best results from it. Read and study carefully the instructions that come with it; also obtain copies of *Exposure Makes the Picture* and *Exposure Makes the Print* by H. P. Rockwell, Jr., of the Weston Electrical Instrument Corporation, of Newark, New Jersey.

COLOR TEMPERATURE METER The new Eastman pocket-size Color Temperature Meter will enable you to measure the color temperature of your illumination, which—although especially important in connection with the transparency processes—is practically of equal importance with the operation of one-shot cameras. The meter may be used with either artificial or daylight and will enable you to make necessary compensation for the degree the light you intend using varies from that for which the film or camera has been designed. Heretofore nothing for this purpose was available for less than between $150 and $200. This meter costs $27.50, and is helpful to anyone wishing to obtain the best results in color photography consistently and under a variety of lighting conditions.

PLATE HOLDERS There is always this to be remembered in connection with plate holders in which separation negatives are to be made: they MUST bring all three images into focus in exactly the same plane in order for them to be of identical size. Ordinary commercial plate holders for black and white work are not reliable for color work, as the plates are liable to lie in them at slightly different depths, which will make a lot of trouble where three separate or simultaneous exposures are being made, which must be so made as to permit of registering such fine detail as eyelashes and the texture of fabrics in a print later on. Though 5 x 7 inch Graflex holders are very well made, for color work it is better to further make

sure by installing springs in each of the four corners, which will press the plate firmly against the inner edge to provide for more accurate registration. Before buying, it is also well to measure these plate holders carefully for depth, using a millimetric micrometer depth gage.

The Devin Colorgraph Company carries these plate holders with springs installed, but, for still more perfect registration, they have gone even further than this in the design of the plate holders for the so-called precision model of their 5 x 7 inch one-shot camera, and also in the newer 6.5 x 9 cm. (about 2½ x 3½ inches) model. In these cameras there are four pins attached to the metal frames back of the filters. There is a pressure spring in the all-metal plate holder, which, when released, presses the four corners of the plate tightly up against these four pins, thus insuring the greatest possible accuracy of registration. Of course, if you are exposing Dufay or Kodachrome, wherein the whole business is done on one film, the matter of plate holders is of much less importance.

A word in connection with the use of the Finlay-type pressure plate holders necessary for bipack combinations: too much pressure, especially uneven pressure, will produce what are known as Newton rings on the films in the bipack combination. These rings appear in the form of a moiré pattern and render hopeless what would otherwise have been a good print. Too little pressure will produce a soft, fuzzy red printer. It is simply a matter of having the proper amount of pressure and contact, and this is gained through the use of the proper thickness of felt pad in the plate holder. This may be checked on by examining one of the bipacks through the glass in the light. All the plate holders may be checked this way.

Plate holders for color work should be numbered. Remember, you are not exposing single plates on the subject, but sets of plates. As each subject in color—other than the single-exposure of Dufay or Kodachrome—requires three plates instead of one, numbering is imperative for identification of the sets. Furthermore, each plate should be identifiable for color, which may be done by lettering R, G, B for red, green, and blue filters respectively in one top corner, or by painting on them a red, green, or blue band or square. The most convenient method of numbering is: Red—1, Green—1, Blue—1; Red—2, Green—2, Blue—2, and so on. See Fig. 2, p. 178.

FILTERS In "Color and Photography," Chapter 1, we have seen how the three filters analyze the colors of a subject, so it remains to discuss merely their application to the camera.

The finest gelatin filters obtainable are those cemented between optical flats. These are quite expensive. The second best are cemented between B glass; and the third and least expensive form in which filters may be bought is in the gelatin itself. As long as this gelatin is kept perfectly clean, free from dust—never touched with the fingers—due to its extreme thinness I am inclined to think it makes the most satisfactory filter material of all, for there is no chance of distor-

tion or slowing down of exposure from thickness of glass. For separation work of ordinary still life, or interiors, the most convenient method of employing filters is to mount them between stiff black cardboards, bind the edges with Scotch mounting or lantern slide tape, and slide them successively before the lens through a combination filter holder and lens hood which is attached to the front of the lens —See Fig. 2, p. 178. You may need to have this lens attachment made to order, probably of brass blackened with acid, although I think that the Hollywood will serve pretty well just as it comes.

All filters, especially the plain gelatin ones, should be treated with the greatest care. Those mounted in glass may be cleaned with lens cleaner; the plain gelatin ones should never be touched with anything but a very soft camel's hair brush, and even with this as little as possible.

It is best to use the filters made by the manufacturer of the plates you decide to use: Ilford tricolor filters with Ilford plates, Eastman or Wratten tricolor filters with Eastman plates or films; because, although most all tricolor filters look more or less alike, each manufacturer has different theories about cutting the spectrum and overlap, and has planned his filters in conjunction with the color-sensitizing dyes in the emulsion coating of his plates.

Besides the tricolor filters, there are also compensating filters as, for example, the photometric 86-C filter used in connection with the Devin camera to hold back the exposure of the blue plate for flashlight work. These photometric filters in the 86 and 78 series may be used for restoring the balance of one-shot cameras when they are used in a light for which they were not originally balanced. As you go into color work from whatever angle, familiarity with the subject and the manufacturers whose products you are using will acquaint you with the different filters necessary for different purposes.

It is customary in color work to use the tricolor filters in this sequence: red, green, and blue—corresponding to the plate holders marked red, green, and blue.

DUST Dust and finger marks are the greatest dangers to be guarded against before exposing in connection with the use of filters, plates, plate holder slides, and more or less everything to do with color photography—especially with the one-shot camera.

TONE SCALES The tone scale, otherwise known as the gray scale or gray step wedge, must always be included in all color compositions if a print is the ultimate objective, as it is the key to color balance. This holds true unless your composition contains a white or neutral gray object which can be used in place of it. However, long experience and familiarity with color work proves that its inclusion, if not absolutely imperative, is certainly a lot more convenient in the long run. It is often a nuisance to do this, and the more devices available for easily and dextrously placing it where you want it in a hurry, the quicker the

taking procedure will progress. Flexible arms, ball-and-socket joints, and an easily adjustable stand will help.—See Fig. 2, p. 178.

SIZE OF TONE SCALE As it is desirable that the tone scale appear in your negative of a sufficient size to permit of measuring with a densitometer, you will find that you will need a much larger one when photographing an interior or exterior in which the area included is much larger than that of a small still life, where a much smaller tone scale will do. Eastman makes these scales of grays in small, medium, and large sizes, but for certain large-size, outdoor shots or interiors you will probably have to make your own. A simple and yet quite adequate form may be made from semi-matt bromide paper.

Without exposing, fix out a sheet which will give white. Expose another sheet to plenty of light, develop and fix it to give black, and fog a third sheet to a half-tone gray. Remember that a half-tone gray lies midway between black and white, and when viewed between the two extremes should merge neither with the black nor with the white. Another method for obtaining a half-tone gray is by ruling off with India ink and a ruling pen a surface with alternate black and white squares, which, of course, will give you a perfect half-tone gray when these squares merge at a distance, as the surface is made up of equal proportions of black and white.

You had better get on a nice friendly basis from the outset with your tone scale, because you will find it will rapidly progress from being a new acquaintance to becoming a greatly valued friend—and what a friend in time of need! For this reason, the cleaner you keep it, the better you light it, and the larger you photograph it, the fewer the headaches later.

A good deal of further information about the use of the tone scale will be found in Chapter 3 on "Lighting and Exposure," in Chapter 8, "Printing Processes," and in Chapter 7, "Separation Negatives."

TRIPODS Most amateur snapshots are probably made without a tripod. Although it is a lot of trouble to lug around a tripod and erect your camera on it before taking a picture, most professional pictures are made on tripods because it is the best way to make them—that is, except for the so-called candid camera shots.

One virtue a tripod must have more than any other for color work is freedom from vibration, and complete rigidity. This applies to any photographic work, but more especially to color. For sets of separations made with an 8 x 10 inch view camera I use a heavy motion picture tripod and have my camera bolted onto a relatively heavy aluminum plate which is in turn fastened to the tripod top, Fig. 2, p. 178.

If you are making three successive exposures on which you expect to register every hair line, one on top of another, in the final print, the slightest slipping of

any adjustment on your camera or movement of the tripod occurring during or between the exposures will ruin your set of negatives and make it impossible for you to get a good color print. If anything like this happens, *which must not happen,* you might as well stop right where you are and start exposing a whole new set. For the same reason, all adjustments on the camera and tripod should be securely locked in place before starting exposure.

As all color photography is much slower than black and white, you will not do much successful work without a tripod, except with a miniature camera. The imperative requirements of a good tripod, as I have said, are rigidity and stability. In order to gain these, the tripod should preferably lean toward the heavy side in relation to the size and weight of your camera to function efficiently.

CARE AND EQUIPMENT OF TRIPODS Metal points at the ends of the tripod legs should be kept sharp by filing them occasionally, and a chisel edge is superior to the usual round point, for it will hold even on marble and smooth cement floors. The ends of the tripod should be well dug into the floor or carpet, if need be, before starting to expose a set of plates. A triangle of wood boards may also be laid on the studio floor if it is made of cement, and the tripod points dug into this.

With the lighter types of tripods for lighter cameras, it is just as well to secure a tripod brace which may be locked into position before starting to expose, because—once again, remember—you are going to turn your film, or change your plate holders, and move your filters three times before the exposure is completed, unless you are using either a one-shot camera or Dufaycolor or Kodachrome. With Dufay and Kodachrome and single exposure cameras, the tripod needs to be only heavy enough to keep the camera perfectly motionless during the single exposure.

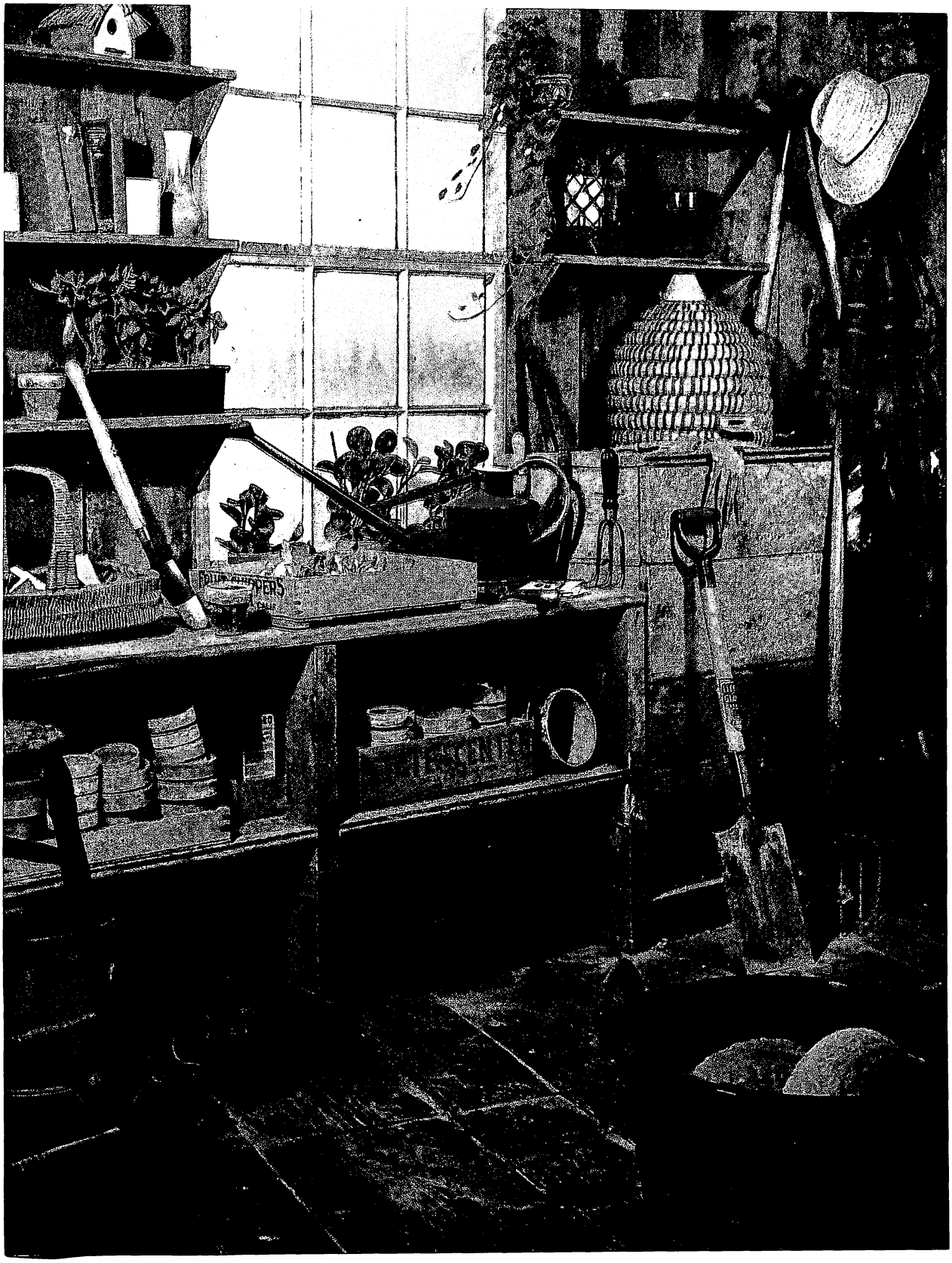
As I think I have made clear, it is a good deal better to err on the heavy side than on the light side in selecting a tripod for color photography.

ACCESSORY EQUIPMENT A magnifying glass applicable to your ground glass is very useful for critical focusing. So is a monochromatic viewing filter, which reduces color to its approximate black and white tone values. This gives you an opportunity to study the tonal and light intensity contrasts without the attendant possible confusion which results from viewing them in color.

In professional color photography, one eventually acquires quite a bag of useful little gadgets, such as: Moore's push pins; Scotch mounting tape for fastening the several sizes of tone scales suitable for different size compositions onto every and all surfaces; small clamps; screw drivers; pliers; camel's hair brushes for dusting off filters; a bottle of lens cleaner for cleaning filters or lenses; and a piece of mirror the size of your ground glass, the edges and back of which can be covered with medical tape, which is useful for seeing the composition right side up when using a view camera. I have found it very convenient to have a little

rolling table beside the camera to hold these and other necessary articles while I am working. You will find as you progress in color photography that you will gradually acquire your own bag of gadgets for various purposes.

Now that you have had an opportunity to examine the cameras available for different purposes and have perhaps decided what you will need, you must remember that the camera will not produce good results for you unless it is used properly and with the right lighting, which matter brings us to the next chapter.



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LIGHTING AND EXPOSURE

COMPARISON OF LIGHT SOURCES The basic difference between lighting for color and lighting for black and white is this: in black and white, modeling is done with shadows; in color, with highlights. Of the various types of light available for color photography, daylight is the most variable, artificial light the most dependable and controllable, flashlight the speediest, and flat lighting the safest.

The flatter the lighting the easier it is to render all the colors in the subject truthfully. This is partly because different depths of color have different light reflecting or exposure values. A medium colored subject will require fifty per cent more exposure than a light subject, and a dark colored subject twice the exposure. When this situation is complicated by different degrees of lighting intensity produced by strongly modeled lighting, the correct rendering of color becomes increasingly difficult, unless compensation is adroitly made by locally increasing the brightness of certain areas of the composition.

Daylight is spoken of as if it were a constant, unique kind of light, whereas in reality, in spectrum analysis, it not only varies in different climates and at different times of the year, but even every hour of the day. Even bright noontime sunlight cannot be depended upon as a constant, for on the same day it will be found to be of an entirely different quality in New England, for example, from that in Florida. The main change that occurs in daylight is that it becomes bluer

or redder. It is generally spoken of as yellower, although it really swings from the blue toward the red end of the spectrum. The difference in the spectra of various kinds of light can be measured, and these differences are rated in degrees of color temperature on the Kelvin or absolute thermometric scale. The redder the light, the lower the color temperature; the bluer the light, the higher the color temperature. Sunlight alone has a color temperature range of from 4900°K. to 6500°K. Let us say, therefore, that it has a mean average of 5700°K., and between sunlight and various degrees of cloudiness there is a still wider difference of color temperature, for light under these conditions, being much bluer, may have a color temperature as high as 6700°K. Now let us quickly contrast the color temperature of daylight with that of ordinary house lighting with its average color temperature of only about 2800°K., and we shall see immediately what a great difference exists in the amount of yellow and blue in so-called white light as we generally experience it in our daily lives.

Artificial light varies to a great degree. To give you some idea of how much it varies, here is a table of the color temperatures of various light sources that Mr. W. H. Walters very kindly got together for me:

CONTRAST BETWEEN MEAN AVERAGE SUNLIGHT (5600°K.) AND THE COLOR TEMPERATURES OF VARIOUS TYPES OF ARTIFICIAL LIGHT

Daylight fluorescent lamp (cold north light)	6500°K.
No. 1 photoflood	3480°K.
No. 2 photoflood	3430°K.
No. 4 photoflood	3390°K.
100 volt, 500–10,000 watt lamps	3390°K.
Movieflood lamp	3380°K.
C.P. (color photography line) 105 volt, 500–10,000 watt lamps operated on 115 volts, used for Technicolor	3370°K.
New line, from 500–5,000 watts, specially balanced for Kodachrome	3200°K.
Ordinary 1,000 watt general illumination lamp used to light up outdoor gas stations, for example	3000°K.
100 watt household lamp	2835°K.

NOTE: These color temperatures unfortunately do not remain constant. For example, the movieflood lamp, after from two to three hours, appears to go down to a color temperature of about 3200°K., where it remains for the rest of its life.

Mr. Ralph Farnham, of the General Electric Company, in a lecture once demonstrated the difference in color of various light sources in this manner: He had a long box in the front of which were four windows, three covered with ground glass; behind these glasses were bulbs. He first turned on an ordinary house bulb in window No. 1, which appeared as reasonably white light in the artificially lighted

lecture room. Then he illuminated the second window by means of a photoflood lamp and, by contrast, made the first lamp appear quite yellow. When the third window was illuminated by a photo-blue glass bulb, it made both the others look yellow by contrast, and when the fourth window was illuminated by a high intensity bulb behind a piece of special Corning, blue-daylight filter glass, it appeared as a really very blue square of light. It was, however, the closest approximation to true daylight thus far devised. The contrast between this and all the surrounding light was startling.

For example, if you have a lot of photoflood light in the studio—and photoflood bulbs certainly give a much whiter light than the ordinary incandescent lamps—when you look out through a window to daylight, you will see what an enormous difference there is between daylight and photoflood light, and how very blue daylight looks under these conditions. This is especially noticeable towards evening.

FILTER FACTORS As we have seen that the balance between the red and blue ends of the spectrum changes with various light sources, photographing in different kinds of light necessitates changing the multiplication factors or exposure times given for the three filters to fit these changes in the character or balance of the light. The factors vary as the light changes in color. Daylight, as we have seen, is quite blue; whereas artificial light contains much more red. The multiplication factor of the green filter, however, remains nearly constant in all types of light. Thus the change from artificial to daylight may be regarded as a see-saw, the fulcrum of which is the green filter. In artificial light, the factor of the red is low, but increases considerably in daylight, whereas the blue has a high factor in artificial light and decreases in daylight. It is important to remember that electric light varies in color depending upon the type of bulb used and the value of the voltage, and daylight varies according to the season and the hour of the day. Ordinary room light (color temperature approximately 2780°K.) is very yellow, movieflood (color temperature 3380°K.) is slightly bluer, and photoflood light (color temperature approximately 3480°K.) is, comparatively, quite blue. A card will be found in each box of plates or films which gives the approximate A, B, and C filter factors for artificial light and daylight. That is, the number of times the regular black and white exposure must be increased to produce the same exposure through each of the three color filters. Roughly speaking, the following are the average filter factors for artificial and daylight:

	A *Red*	B *Green*	C or C-5 *Blue*
Artificial light	2.5	8	12
Daylight	5	8	6

Note that half the exposure necessary for the red filter in daylight is required

in artificial light, for—as we have seen—artificial light has much more red in it. The same principle applies to blue in daylight, which is bluer.

It is always best to check all filter factors because they vary, depending upon individual working conditions. If the factors for the type of light you are using do not appear on the card, they can be worked out, using those given as a point of departure, by exposing on a gray tone scale and measuring this scale in the negatives with the simple densitometer, which is explained in "Separation Negatives," and Fig. 6, p. 180, Appendix.

EFFECTS OF VOLTAGE DEVIATION As I have said, incandescent lighting is probably the most dependable and also the most controllable. However, fluctuations in voltage can affect it to quite an extent. For example, a 5 volt deviation or drop would mean a 50° change in color temperature, a 3200°K. lamp becoming 3150°K. A 10 volt drop in the voltage, caused by too small a cable to a 120 volt lamp, would mean that the lamp was operating on only 110 volts, resulting in a loss of about twenty-five per cent of the light output, not to mention the much lower actinic value and complete change in spectral balance to a much redder character. Of course, this will throw out the color balance of a set of plates.

MIXED SOURCES OF LIGHT It is often said that mixed sources of light should not be used for color work, and this is really true. However, I have been obliged to use different sources because, as you will notice from the color temperature table, it has not been possible—and still is not possible—to get movieflood, and 2000 and 5000 watt lamps of exactly the same color temperature as No. 2 photofloods. If some manufacturer would make a high intensity photographic lamp that would more closely approximate daylight than any on the market today, and if these lamps could be obtained in any size from 500 watt to 10,000 watt, I think they would certainly be the best lamps to use.

QUALITY IN LIGHTING Due to the extreme slowness of all color films and cameras, and the consequent necessity for obtaining the greatest possible efficiency from the amount of light used, the *quality* of the light employed has frequently suffered. Really efficient artificial lights do not give the best quality of light, for efficient lighting is liable to be harsh or hard. Harsh lighting is never as good for flesh tones and portraiture as soft, diffused lighting; in my experience, it never was in black and white photography and certainly is less so in color.

HOW TO LIGHT FOR COLOR The way to light for color is to flood the subject evenly with enough light to give an adequate exposure and then to snap on highlights here and there wherever needed to keep the composition from becoming monotonous. Then, using small spotlights, go around the subject and plug up the dark holes in the lighting where underexposure may occur, with consequent loss of color rendering. Remember that in color photography contrast is gained through differences in color rather than differences in light intensity. At

all events, it is much safer and better to start out with flat lighting and then with experience find out just how far you can go towards more contrast. Always remember, if your subject is away from the background, that you will need as much extra light on the background as there is on the subject, if you do not wish the background to be much darker in your picture than it appeared to the eye. As the tone scale is often applied to the background, this extra light is important to insure its receiving the same lighting as the rest of the subject; otherwise it will be underexposed in relation to the subject as a whole, with consequent loss of much of its value as a guide in printing.

LIGHTING SETS When building up a set in the studio, whether it be a large one like "The Potting Shed" shown in this book (Plate 3), or a small one such as a still life on a table top, it is very important to do so in such a manner as to permit of the greatest possible scope or flexibility in subsequent lighting arrangement. In other words, you have to be able to get lights in all around the subject. You should pretty well foresee your lighting before building up your set.

PHOTOFLOOD LAMPS A very satisfactory way of providing this basic or underlying exposure lighting is by means of strips which are used to frame the subject and suffuse it with an all-over relatively soft light. With these strips, you may use a single powerful source of light to give directional light or modeling. Fig. 1, Appendix, p. 177.

I would suggest using photofloods for this strip lighting because, for one thing you will get much more light out of them for the amount of current consumed. This is not so much from the standpoint of the current actually used as from that of the expense entailed in an installation making possible the drawing of the same amount of photographic light on a straight current ratio. I was one of the first to use photofloods because their quality was much closer to that of daylight than any other lamp obtainable at that time, and because I felt that if some single quality of light had to be settled upon, daylight was probably the best because it is the most basic. Of course, photofloods were quite new and the whitest light available at that time. Since then, various new lines of lamps have been put on the market. For instance, photofloods are now being made with blue glass to give a whiter light, and I have just heard of a contemplated line that is attempting to match the color temperature of daylight at different times of the day. If this were done with flashlamps, it would permit of using them out-of-doors to light up shadow areas as they are now being used in black and white photography. I still use photofloods, although there is no doubt that their color temperature varies. Moreover, towards the end of their life, they have lost one-third of their light output as well as having become much redder. For this reason it is very unwise to light one side of a subject with brand new photofloods and the other side with used bulbs. It is much better to keep them all mixed in together and in balance as much as possible.

REFLECTION VALUE OF COLORS Dark colors reflect much less light than do bright ones. Some textures absorb more light than others—for example, bright, light-colored satin, alongside dark-colored velvet; or notably, dark furs alongside light flesh tones. It is better to measure these two surfaces separately, and if using artificial light, add enough local light to the velvet or fur to bring its exposure value up somewhere near that of the satin or flesh tones, if it is desired to preserve fidelity of color and texture in both. Similarly, it is not unwise to go around and measure locally the lighter and darker parts of a color set-up, as the darker parts may need well over double the exposure of the lighter ones. This is a very good way to learn lighting for color; and if you get in the habit of checking different areas of your composition, you can see which ones need more light, and when you are using artificial light, act accordingly.

Another rule, that I have heard is used in motion pictures, is that no light coming from any one directional source be more than four or five times as bright as the others. Another viewpoint is that it will usually be found that if the lighting is fairly well done and even, the measurement obtained on the exposure meter from the position of the front of the camera will usually prove satisfactory, and will come to about the same reading as the average obtained from individual measurements.

COLOR REFLECTIONS Color reflections must always be taken into consideration. Take, for example, a boat anchored in the water on a bright, sunny day. Let us say it is red and that it also has a red deck house. The boat is all painted with the same red paint, but the red near the water line, due to picking up the reflection of the blue water, will have a much more bluish cast than the deck house farther removed from this reflecting surface. This fact will probably be much more noticeable in your color transparency or print than when you made the photograph, because you were then out in the bright open light with the color of the water and the sky around you. All the colors seemed to be in relation to one another and you just accepted them without analysis. In other words, you did not look carefully and take note of just what colors were where, and just what colors they were. As another example, look down on a shiny black automobile on a clear day and you will see that it reflects the sky sufficiently well to appear as a really blue car.

Delicate flesh tones are particularly susceptible to the effects of color reflections, and the greatest care must be exercised in connection with them—especially in photographing the nude. Always remember that if your subject is too close to the background, the background will throw color reflections into it. In all color photography, color reflections are always to be guarded against.

To photograph in color successfully, you must learn to really see and analyze the color in objects in the light in which they are photographed. The colors in certain parts of your prints will often surprise you, especially at first, but if the

prints are reasonably well made and correct, you will see in them the colors actually photographed, as they were rather than as you thought they were. To be able to see color clearly and correctly is quite an art in itself which requires a good deal of practice. Unfortunately, all people are not able to see color with the same degree of facility or accuracy, any more than all are able to appreciate music or carry a tune.

AVOIDING COLOR REFLECTIONS IN THE STUDIO In the studio, where light is under control, the use of flat, diffused lighting reduces the chance of encountering unpleasant color reflections to a minimum. Until you have had considerable experience with color lighting and know what to look out for, you will be surprised when you find out how much color can bounce off brightly colored surfaces into adjacent colors and distort them. Spotlight-type, harsh lighting greatly increases the possibility of such unpleasant results. For this reason, the studio in which color photography is done should be painted pure white, neutral gray, or black. A bright or even moderately bright colored wall will throw enough color into a face to completely upset the natural rendering of flesh tones. I prefer a white studio, which permits of taking advantage of the reflected light for increasing and softening the general illumination. Of course, in a black studio you get light only where you put it, but the same conditions can be reproduced by means of black screens when there is a definite necessity for this sort of lighting. Neutral gray will serve about as well as white if you prefer it.

Even in a neutral-colored studio there must be no colored objects around from which colored light can be reflected back onto the subject. When working very close to a small still life set-up, I have found that even the reddish-brown wood of the front of my view camera has been able to throw color reflections into light-colored subjects, and I have been obliged to cut a hole in a piece of white cardboard and photograph through it. I suppose for this reason that black is preferable as a finish for cameras when used for color work.

COLOR REFLECTIONS ON LOCATION When making color photographs on location, I take with me a set of white sheets which can be hung from portable stands, thereby completely boxing in the subject with white and reproducing studio conditons.

EXPOSURE Without doubt, nowhere nearly as much latitude in exposure is permissible in color work as in black and white. Therefore, all serious intentions regarding color work take for granted a good exposure meter kept in perfect adjustment. This is especially true relative to the transparency processes, Dufay and Kodachrome, with which it is said exposure must be correct within one lens stop. But when we consider that the difference of a stop means either double or half the exposure, I am inclined to feel that exposure with these transparency processes should actually be much closer to one hundred per cent than this, in order to arrive at really fine color rendering.

COMPENSATING FILTERS Fortunately, some permissible margin of error exists in the exposure of separation negatives, as compensation for it can be made later in printing; but with Dufay or Kodachrome, where the balance of colors is irrevocably established at the time of exposure, the quality of the light, that is, its color temperature, should be very nearly correct if the best result is to be obtained. When the light used for taking a picture varies from the light for which the film or camera was designed, compensation must be made for this condition by using photometric filters, such as Eastman's No. 86 series (yellow, with three degrees of difference) to hold back any over-amount of blue rays; or the No. 78 series (blue, also three degrees of difference), or the new Eastman C C Filters—four blue and three yellow—for holding back an over-amount of yellow or blue rays in the light. These filters are equally applicable to one-shot cameras. For example, when a one-shot camera balanced to photoflood and flashlight is used in daylight, it is necessary to add an 86 B filter to hold back the excess of blue rays, or the blue filter negative (yellow printer) would be very much overexposed. With the Devin camera, balanced for artificial light of 3250°K., or daylight, 5400°K., this is accomplished by interchanging the position of the filters—placing the red filter where it will receive more exposure and the blue where it will receive less; but here, too, compensating filters must be made use of for flash or unusual daylight conditions. For Kodachrome and Dufay, special filters for this purpose are issued by the manufacturer.

COLOR TEMPERATURE METER The Eastman Kodak Company sells a small color temperature meter to be used with Kodachrome which also works well with the one-shot cameras balanced to around 3200°K. This operates as follows: A reading is taken through the eyepiece of the meter on a piece of special white paper held in the full rays of the light being read. The meter should be set at 3200°K. before commencing. If the split field seen in the eyepiece does not match, a series of four blue filters for raising the color temperature, and three yellow for lowering it, is available for use with the meter. By trying these filters over the eyepiece until the fields match, the proper filter is found to restore color balance, and it is used over the camera lens for taking the picture in that particular light.

EFFECTS OF OVER- AND UNDEREXPOSURE ON COLORS Overexposure means diluting colors with white; underexposure results in clogging them with black. Overexposure of highlights in black and white may result in snappy prints and sometimes happily exaggerate pattern, but in color work it merely means burnt-out highlights, empty of color and blocked up shadows likewise empty of color. Take this example: It is three o'clock on a winter afternoon; the sun is rather low, illuminating the subject—a couple of red barns—from the side; the side of the one nearest the camera is illuminated obliquely by the late afternoon sun, its front and the side of the other barn are in shadow. In front of them, in the foreground, is a pile of wood stacked up with the ends facing the

camera and fully exposed to the sun. The ends of the pieces of wood are brilliant yellow, as the sun smacks straight down on them and makes a nice bit of color contrast to the eye in front of the red barns. In this contrasty light, the subject is not a practical one for color photography, from an exposure standpoint. Exposing sufficiently to get color and detail in the shadow parts of the barn will result in great overexposure of the ends of the wood, and they will not turn out yellow in the final print but will be merely burnt out leaving an empty white area which will stand out most unpleasantly. If the yellow of the wood is obtained by printing down, the shadow parts of the barn will, of course, be merely an empty black.

If large aluminum foil-covered reflectors, which the motion pictures constantly make use of for outdoor shots and which are very necessary to have on hand, had been available for throwing light into the shadow parts of the barn, and helping to balance the illumination, there might have been some chance of photographing this subject successfully. Of course, another thing that would have had to be borne in mind in connection with this subject was the yellow quality of the late afternoon sunlight, and compensation would have had to be made for this with one of the previously mentioned photometric filters.

EXPOSURE VALUE OF VERTICALS AND HORIZONTALS The tops of horizontal objects or planes reflect somewhere around fifty per cent more light than do the sides of vertical objects or planes. To get some idea of how important this is, let a single source of light shine down on a piece of white cardboard lying on the top of a table. Measure the light reflected from this surface with your Weston or General Electric meter. Without moving the light, tilt the cardboard gradually until it is vertical. Notice how your meter reading changes.

LIGHTING INTERIORS

Photographing interiors professionally requires portability of lighting equipment and enough current available to make use of sufficient equipment to properly light up colors. It often takes quite a bit of light to do this.

For these subjects, extra lengths of cable are essential to have on hand, because in order to reach from the plugging box to certain lighting units it is often necessary to take a very circuitous route to keep the cables out of sight. The plugging box, from which branch out the various lighting units, should be equipped with several hundred feet of heavy cable in order to hook it up to the main fuse box where the current comes into the building; the fuse box may be some distance away from the room photographed.

LIGHTING ALL WALLS TO THE SAME VALUE Projected floods having as small a hot spot in the middle as possible are useful for this purpose, because they reach in from a distance and take care of surfaces which can not be lighted by strip lights, for they would show in the picture.

When you are photographing the side of a room in which a mirror plays a

prominent part, and in this mirror is reflected the opposite side of the room, the area in the mirror should naturally be carefully and tastefully furnished and arranged to present as nice a composition in the mirror as possible, and lighted to the same, or nearly the same, intensity as the side of the room that your camera is pointed toward—this, of course, depends upon the effect you wish to obtain. Projected floods are quite useful for this purpose, and sometimes must be directed almost right at the camera. To keep their light out of the lens, black screens or anything else you can find around can be adroitly interposed between the light source and the lens.

CEILINGS AND HOW TO HANDLE THEM If the walls are suitably lighted, the ceiling often appears likewise to the inexperienced eye, but if what I have said about proportions of light in one area in relation to another is borne in mind, and a Weston reading taken on the ceiling, it may be found to be either too light or too dark for the result eventually desired. It depends, of course, on whether you want the ceiling to be light in the finished picture—if that suggests the inherent character of the room; or whether to have the walls grade up into shadow toward the ceiling suggests or interprets more correctly the particular character of a given room or interior.

BALANCING INTERIOR LIGHTING AND PLUGGING UP SHADOWS If you light a room for color photography, or for that matter for black and white photography, to your eye, certain places in shadows underneath desks or chairs may seem relatively well lighted, but checking with the Weston meter will prove them to be away out of proportion in exposure value to surrounding areas. If you do not want these to appear in the finished print as unpleasant, empty, black holes, you must get light into them, which is sometimes not so easy to do—and at the same time keep these sources of light out of the picture area. Small spotlights are useful for this purpose. This same rule applies to dark woods, such as the front of mahogany or walnut cabinets, etc. Dark woods, and carpets especially, absorb much more light than light walls, and it is necessary to project considerable extra localized light on them if you want the grain of the wood and its proper color, and the pile of carpet to appear as they should in the finished picture. A fireplace is another thing that usually needs considerable extra light projected into it locally to raise the exposure value.

The reverse of this applies to the lighting of light areas, like light wallpapers in which there is a design. If they are over-lighted with relation to the rest of the composition, the negative will be blocked up too much in these areas making it impossible to reproduce the design of the wallpaper.

NORMAL ROOM ILLUMINATION If you have a lot of bright light on an interior, for example some two hundred amperes, the ordinary house bulbs lighted in table or bridge lamps will not show up at all. So if it is desired to show a given room with night lighting, it will be necessary to substitute brighter photo-

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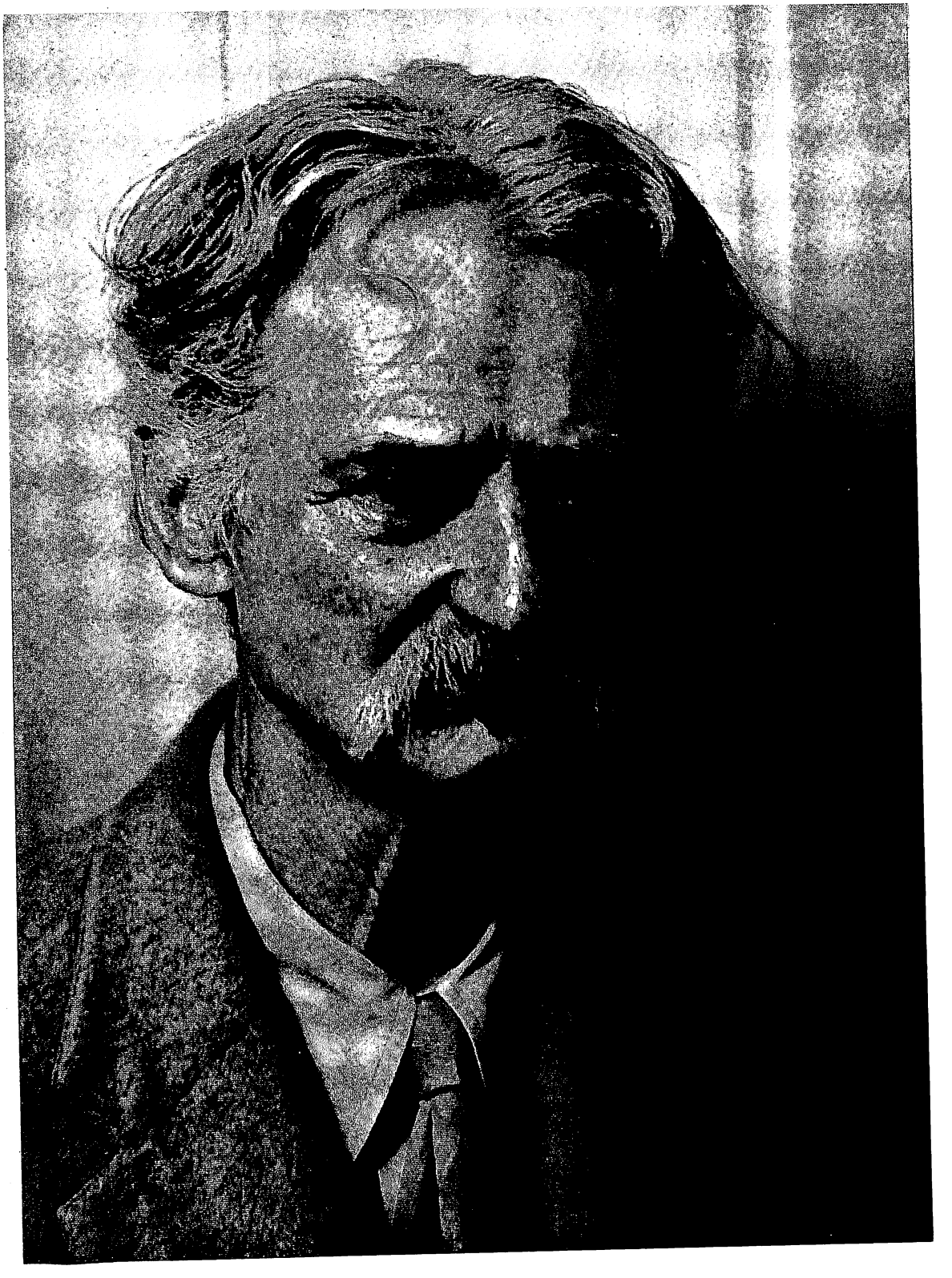


graphic bulbs in place of the house lamps. No. 1 photofloods are especially suitable for this because they are small enough to fit into ordinary lamp fixtures, and if they are well ventilated, they work out quite all right. However, they will usually be found to be too bright, burning out all detail in the lamp shade and otherwise presenting the effect of an overexposed blob of light instead of a lighted lamp. To take care of this you can turn these bulbs on for only a part of the exposure. This portion will have to be estimated, and checking with the Weston meter will help.

Let us say twenty-five per cent of the total exposure is found to be correct for a given condition, and that the exposure for the red filter is 16, for the green filter is 26, and for the blue filter is 18. Exactly twenty-five per cent of each one of these items must be calculated. The camera shutter is opened and the exposure begun with the lamps on. After the requisite twenty-five per cent of the time has elapsed, while still exposing, an assistant snaps a switch which shuts off the room lights that have all been wired together to his switch and connected to a cord which runs into your plugging box. Of course, a conveniently located wall switch will serve if it controls all the lights.

LIGHTING EQUIPMENT REQUIRED FOR STILL LIFE For small still life, fine work can be done with only two lighting units, such as a Johnson Ventlite containing a 2000 watt movieflood lamp for general directional illumination, supplemented by one other element such as the one pictured in No. 11, Fig. 1, p. 177, Appendix, containing a 1000 watt No. 4 photoflood to lighten up the shadow side. (See also Nos. 8 and 10 on the same page). This would represent a total of thirty amperes, which could be drawn in almost any small apartment. Although applicable chiefly to still life, even portraits can be done with this outfit, working with an ordinary view camera, if the subject could be so completely braced that there were no chance of movement during or between exposures, and the lights were placed close to the subject. With a small one-shot or with Kodachrome, head and shoulders portraits are quite possible.

A whole and varied series of beautiful pictures could be made with merely a part of the set of strips—pictured in the Appendix, Fig. 1, p. 177—containing No. 1 photofloods and a single Ventlite containing a movieflood lamp. In practice, however, especially when live models enter the matter, much more light than this is required for regular studio work.

STUDIO LIGHTING The usual artificial lighting equipment for studio purposes will cost anywhere from $500 up to as high as you want to go, depending upon the size of the sets, the tendency to movement in the subjects, and the variety of subjects contemplated—in short, the type of work you wish to do. As a guide to what lights are useful for what purposes, study the data relating to the illustrations in this book. The larger and higher powered the lamps, the greater the electrical installation necessary—which, in turn, entails minimum demand charges by the power company and large bills for current. In certain of the professional stu-

dios, a number of 2000, 5000, or even 10,000 watt lamps are not uncommon, used behind Fresnel lenses in spotlight-type enclosed housings. This sort of equipment necessitates an installation of from at least 300 amperes up to 500 or 600, or more. In contemplating an installation of this sort, it should be borne in mind that cables should be large enough to accommodate the load properly. Otherwise, there will be a loss of light efficiency, due to pulling too much current through too small cables. It is wise to make actual voltage tests everywhere: where the current runs into the building, at the branch-out plugging box, and even at the end of the lead to each individual lighting unit. Fig. 1, p. 177 in the Appendix will give you a graphic idea of what lights are available for what purposes, and an approximate idea of their cost.

It is not absolutely necessary to pitch the lighting on as high a scale as this, and the intensity of the spot or accent lighting required must be in relation to, and is dependent upon, the amount of so-called ground or floodlight used. This in turn is dependent upon the type of subject photographed and the tendency toward movement.

If, in Fig. 1, p. 177, Appendix, No. 4 photofloods were used in place of flashlamps, you would see that the total of the lighting shown in this illustration is around 30,000 watts (about 300 amperes) of actual current drawn, and at least 60,000 watts of photographic or actinic light. Now if, for the sake of greater speed of exposure and efficiency, the lighting is done with a number of 2000 and 5000 watt Fresnel lens units, it can easily be seen that as each 5000 watt unit represents a drawing of about 50 amperes, the total mounts up pretty quickly, and that for any really professional installation 500 amperes is not too much.

For model shots, upwards of 300 amperes of light are frequently necessary with the best one-shot cameras available, for an exposure of only one-fifth of a second. This is pretty heavy equipment for such a result, but there is a way out: you can get the same result, and the same assurance of freedom from movement with flash.

FLASHLIGHT

Experience proves that it is a great deal easier to do consistently successful color photography under controlled studio lighting conditions, but as we have seen, as soon as animated subjects come into the picture—necessitating shorter exposures —a great deal more light is required. If this is attempted with incandescent lighting, the problems of greater heat and higher general costs come up. The only way to get around these successfully is to resort to flash, because cooking the models is avoided—and they can at least get their eyes open.

From certain points of view, however, flash is a nuisance and hard to use, because, relatively, you have to do all your lighting twice over. The only way of controlling the light and obtaining some idea of what you are going to get is with a system of pilot lights. Flat boxes painted matt white inside permit of being wired

with two circuits, one for the flashbulbs and one for the pilot lights—which means that the pilot lights may be kept on up to and during the time of making the flash exposure—unit No. 9, Fig. 1, p. 177, Appendix. Although this is the most convenient way to operate, the light throwing efficiency of such units is pretty low, and you will have to use many more flashbulbs to produce the same intensity of light on your subject than you would if your reflectors were possessed of a higher degree of efficiency.

FLASH REFLECTORS Flashlighting may be accomplished by means of three or four simple parabolic reflectors that scientifically gather up all the light rays of a single bulb to a single point of focus and throw them out to the subject.

It is not possible to use pilot lights wired on another circuit with these parabolic reflectors, for unless the pilot lamp is properly focused in the center of the reflector all its efficiency is lost, and it is not possible to judge of the lighting from pilot lights placed near the edge of reflectors. This system therefore entails changing the bulbs; that is, lighting the subject with No. 2 photofloods, which are replaced by flashbulbs before making the exposure. This operation may be expedited by the use of what are known as quick-change sockets. With these, screwing in and out is eliminated, the bulbs are merely pushed in and pulled out with a single movement. They are somewhat expensive—costing around $3.00 apiece—and as a rule have to be made to order. They are not reliable when used in a position other than upright.

I have heard it said that flash is much easier to use for group pictures or larger compositions than for a single head and shoulder figure, which, to do well, necessitates very accurately controlled lighting. Personally, I have never liked using flash any too well, but since I have become more and more impressed with its advantages and have gained more experience with it, I have grown to like it better. If it is properly handled, the results compare very favorably, in fact, are indistinguishable from those obtained with incandescent lighting. It is probably the most popular method among professional color men for certain figure compositions, because of the slow speed of one-shot cameras—for that matter, of all color materials—and the fact that when a subject is shot with flash sharp results free from movement may be depended upon.

SYNCHRONIZATION VS. OPEN-SHUT EXPOSURE Flashlight exposures may be synchronized with the shutter by means of a synchronizer, which will permit of stopping action by clipping off an exposure of 1/200 second or more at the peak of the intensity of the flash. The amount of light necessary to fully expose large size color materials at such a speed runs into quite a lot of money. Furthermore, a relay, which is a device costing anywhere from $40 to $60 or more, will have to be used. These must often be made to order to fire a large number of bulbs. Both Kalart and Mendelsohn make excellent synchronizers and other flash equipment. Unless there is a definite need for such a rapid exposure, what is

known as an open-shut exposure will usually be found quite adequate. The speed of the flash itself is about 1/50 second, and if the camera shutter is set on 1/5 or 1/10 and the cable release run to a switch which controls both the shutter and the flash, the exposure will be made by the flash in 1/50 second which is quite fast enough for most work. The Victor Synchronizing Switch will be found quite suitable for this purpose.

LIMIT OF SIZE OF FLASHLAMPS I suppose a number of professionals have often wished there were even larger flashbulbs than the No. 75's, but there seems to be some limit to bulb size compatible with efficiency, for when a large amount of foil is ignited some of the burning foil is liable to have a shadow cast over it by that part of the foil which has not yet ignited at a given period. It is on this account that the No. 75 bulbs do not synchronize as well as the smaller bulbs.

UNIT FOR FIRING LARGE NUMBERS OF FLASHBULBS When it is necessary to use large masses of bulbs, lighting units may be made of wooden boxes capable of taking up to sixty lamps (a full case of No. 20's). They are made with a false bottom in which are bored holes into which the screw bases of the flashbulbs are inserted. In the center and four corners of this box are electrical sockets with cable current connection. The flashbulbs are screwed into these five sockets with twenty, thirty, or sixty other bulbs merely set in the holes in the back of the box, but all touching, or very nearly touching, one another. When the current travels through the cable to the center and corner bulbs, the shock or radiation of the firing of these bulbs fires the others, after which, all one has to do is tilt the box forward and all except the wired bulbs will fall out and the unit is ready for reloading. Some of the early hand flash reflectors made use of this principle of firing. They had one center bulb fired by a flashlight battery; the surrounding bulbs clipped onto the edge of the reflector were fired by the radiation from the center bulb. Only foil-filled bulbs fire by radiation.

KEEPING FLASH RECORDS In all flashlight work it is desirable to have on hand a good pocket tape measure, like a coiled steel rule, and keep careful diagrammatic records with measured distances of the light sources you used. This will provide a very useful reference note book for further work.

ESTIMATION OF FLASH EXPOSURES While the pocket tape measure and reference note book is the customary method of estimating flash exposures, it occurred to me that lighting a subject to a constant given light value in relation to a given emulsion speed and lens opening would be far easier and quicker, and would provide greater freedom with just as much control. For example, with the Devin one-shot color camera having a Weston speed of 3, I found that if there is enough light on the subject to cause the Weston needle to read 80, when the subject is lighted with No. 2 photoflood bulbs as pilot lamps in reflectors, such as pictured in No. 10, Fig. 1, p. 177, Appendix, substituting for these pilot lights No. 75

flashbulbs and stopping down to F/32 will produce a satisfactorily exposed negative. It will be obvious that if you use F/22, a Weston meter reading of 40 will be sufficient, or if F/16 is practical, a reading of 20 will suffice, and so on. It is simply a question of establishing a ratio between the pilot lights and flashbulbs, the lens opening and emulsion speed, and the Weston reading.

COST OF FLASHLIGHTING Fig. 1 on page 177 in the Appendix, showing lighting equipment, will give you an approximate idea of the appearance and cost of flashlight equipment. To give you some indication of the number of flashbulbs necessary for doing a knee-length portrait: about five No. 75's and three No. 20's, roughly speaking, will do a job with a one-shot camera stopped down to F/16. At the standard retail price of the bulbs this shot will cost $4.35, but to professional photographers there is a discount of thirty-three and one-third per cent for six or more lamps in cartons as packed by the manufacturer. If lamps are contracted for at an estimated yearly expenditure, this discount increases, depending upon the size of the contract. An ordinary several-figure commercial model set-up may run to $20 or $25 a shot, even with the discount, and some of them have been known to run to a great deal more. But it is to be remembered, that while the cost of a large number of flashbulbs may seem high, it is encouraging to bear in mind that the expense ends with shooting the pictures, and there are not, in addition to the expense for heavy studio lighting and current, the continual minimum demand charges which the electric power companies feel obliged to exact.

Proficiency in flashlight work is something you will acquire only in time with experience, after you have shot off a lot of flashbulbs and shot up quite a bit of money. Lately much has been said about the convenience of flashbulbs for lighting up shadow portions of a subject in doing outdoor sunlight shots. The General Electric and the Wabash companies have placed on the market bulbs made of blue glass to have a color temperature of daylight. With them a camera balanced for daylight, such as the Lerochrome Daylight Special model, may be used in the studio with its regular Weston 12 daylight speed rating instead of having to use it at Weston 6, which is necessary with the ordinary flashbulbs.

LIGHTING THE TONE SCALE Before finishing the subject of lighting, let me remind you of the problem of lighting the tone scale. With whatever type of light you are using, it should receive the same quality and intensity of illumination as that of the main parts of the composition. This is sometimes quite difficult to do conveniently, especially with flashlight, which falls off in intensity very rapidly; but the more trouble and care taken with this matter, the less trouble will be found later in printing.

IMPORTANCE OF LIGHTING KNOWLEDGE In conclusion, you must remember that in photography, in a quite real sense, you are painting with light; and a thorough knowledge of the subject, which is the result of intelligent study and practice, is essential. One of the best ways to start out is by lighting a

cube and a sphere, and then go on to a plaster cast by way of preparing for portraiture. The value of a sound knowledge of lighting cannot be over-estimated, as it is the most important element in all photography. Color, as we have seen, is dependent upon light for its being; photography depends on light for its functioning; and the photographic artist is dependent upon his knowledge of lighting for results, bread and butter, and reputation.

4

COMPOSITION AND PICTURE MATERIAL

COMPOSITION is a whole subject in itself and can be only touched on in a book of this sort. Of course, you can make snapshots without knowing anything about the fundamental mechanics of composition, but you certainly won't get pictures in the true sense of the word. Nor will you design well in color if you lack any inherent or cultivated feeling as to what colors may be combined with what other colors—which is, after all, what taste is.

FORM AND COLOR The underlying element of all fine art is form, and composition is the organization of forms. Objects might be said to have form first and color afterwards as an adjunct to form—for form can be felt in the dark, while color is dependent upon light for its existence.

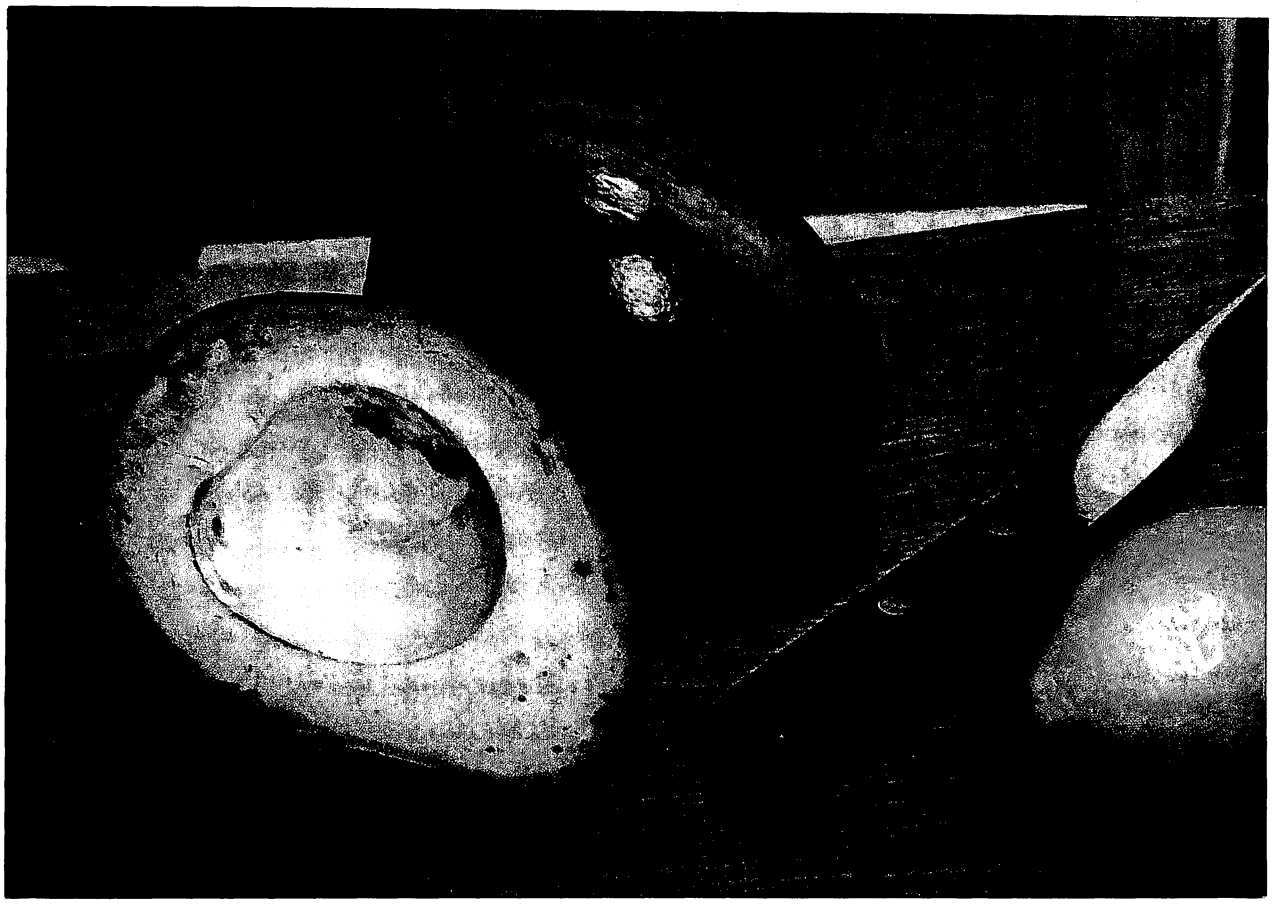
Most monochromatic art, such as certain kinds of architecture, sculpture, lithography, etching, and certain painting, might be said to represent a more intellectual approach to an abstract expression of man's inner dreams. Color appeals more to the senses than to the intellect, as witnessed by the fact that children invariably show more interest in the colored illustrations in a book than in those in black and white. Many of the great masters of painting obviously clearly appreciated this fact, for when they wanted to suggest rugged character a great many of them did so with a nearly monochromatic palette. It was when they wanted to express the qualities of charm, lightness, and prettiness that they used the brilliant colors.

As form is important, and the value of color is greatly increased by giving it shape, the shape of the forms in a composition is very important to the design or arrangement of the picture as a whole. The paintings of the old masters, when seen in black and white, clearly bear this out—for their pattern or form arrangements devoid of color produce rich and significant relationships of forms in monochromatic tones, strongly suggesting color. Just as a really good black and white photographic print should strongly suggest color, so a really good color composition will have an interesting and fine combination of tones if reduced to black and white. A monochromatic viewing filter therefore comes in very handy in planning or arranging compositions.

HOW TO SEE FORM As regards seeing form as such, if you look at objects, such as a chair or table for example, from a purely functional association point of view you merely see the chair as a thing to sit in, or the table as something used for the purpose of eating or writing, and you are missing the artist's-eye view of it. His view would be simply that of a shape or a form in relation to other surrounding shapes or forms. So with this in mind, look around at all the simple, useful things found in any household; look at them in a new way; look at them carefully, and at their shapes, which is the pictorial way to look at objects. You will find that some objects have very exciting forms and lend themselves readily to pattern arrangement much more than others. However, when one gets right down to the matter of sheer transcendent beauty, it is practically impossible to improve upon the form of, let us say, a pyramid. The ancient Egyptians were undoubtedly well acquainted with this fact. All the basic type forms, such as the cone, cube, plinth, sphere, and ovoid, are fascinating, and they are the bases from which all varieties and adaptations have sprung. Plate 1, p. 7, demonstrates the compositional possibilities present in very simple forms.

PLACEMENT Composition is the organization of forms, and pictorial composition is the organization of forms within definite limits or boundaries. In photography, this boundary is represented by the area and shape of the ground glass, or the viewing frame or finder of the camera. Forms cannot be scattered around in a haphazard manner within the confines of the picture area and produce a result possessed of unity and balance, and good art is dependent primarily upon these two elements.

As a quick way to begin learning something about this, try placing a single spot in an interesting manner within the limits of a given area. You will find that if you place it directly in the center it will balance in relation to the boundaries of the area, but this placement will provide only mechanical balance and be somewhat stupid or uninteresting; and although by actual measurement the spot will be in the dead center, it will appear as below the center and falling to the eye. Raise it up to where it looks right to the eye—to an optical center, so to speak.



Then see if moving it slightly to the left of dead center doesn't relieve the static feeling and give more animation to it without the loss of a feeling of balance.

BALANCE Now that you have found out how to place a single spot within definite boundaries, you can next try to place two spots within the same area. You will then immediately find yourself confronted with a problem of balance. There is always present in good composition the weight of areas of tone or color, which must be properly counterbalanced by adequate other weights. Fundamentally, the principle of this is entirely mechanical, and there is probably no better way to clearly demonstrate it than by the use of the old steelyard balance. Figs. 15 through 19, p. 184, Appendix.

As we have already suspected, purely formal symmetrical balance is liable to be somewhat dull and static, although perhaps the most satisfying to the aesthetically undeveloped. A good example of purely symmetrical balance, with which everyone is familiar, is that usually present on a mantelshelf where, for example, a clock may be centered with an identical candlestick at each end. Although there are times when purely symmetrical balance must be used, asymmetrical balance is much to be preferred to the purely symmetrical, and, if anything, it is certainly much more intriguing and entertaining. Perhaps the whole idea underlying man's feeling for the necessity of balance may be traced to his being obliged to stand erect and balance himself, but whatever its origin, this feeling exists and must always be taken into consideration in all pictorial composition.

BALANCING COLORS Now, in applying balance to colors we must bear in mind that there are what is known as advancing and receding colors, and there are intense and less intense colors. Take red, for instance: it is an advancing color—comes right out at you; whereas blue, most commonly associated with the sky, might be said to be a receding color. Yellow will carry farther than any other color. I found this out years ago when I designed posters for the theatre. Colors also have intensity or saturation, and are termed saturated when in their purest state. A small amount of an intense or saturated color will balance a much larger amount of the same or another less intense or saturated color. When a color is diluted with white it is said to be a tint of the color, and when black is added to a color it is said to be a shade of the color. Intensity obviously applies equally to black and white tones, as a small concentrated black area will balance a much larger area of gray.

Balances and counterbalances are obtained in color composition by brightness and area. A rather large area of blue, which is a somewhat passive and receding color, may be balanced by a much smaller area of red, which is a more brilliant, active, and advancing color. Of course, some reds may be very dull and some blues very intense or vivid. Also bear in mind that the brightness of any color is increased by placing it next to its complementary.

COLOR COMBINATIONS It is to be remembered that there are ordi-

nary combinations of color and distinguished combinations of color. There are crude combinations of color and subtle combinations of color. A great deal of inherent talent further developed by constant application and practice is required to produce the fine combinations of color created by the great masters of painting.

UNDERLYING ABSTRACT DESIGN The very directional quality or arrangement of lines and of the shapes of masses may be static, soothing, irritating, or dramatic—even without relation to any actual subject matter. For this reason I like abstractions, as they are apt to permit of a purer enjoyment of line against line and tone against tone without the distraction of any sentimental association.

Therefore the underlying abstract design of any worth while pictorial composition is important. Just as a piece of sculpture, or even the human body, is erected around a framework, so a pictorial composition has to have a skeleton—and this is the underlying simplified combination of first lines, then shapes, as such.

BASIC TYPES OF COMPOSITION There might be said to be three basic types of composition: vertical or horizontal, angular, and circular. Horizontals suggest peace, tranquillity and a somewhat static condition. To cite two examples quickly: the horizon line of a calm sea; a recumbent person asleep or otherwise. Verticals suggest strength, majesty, and dignity. Examples: towers, church spires; towering trees; classically-robed, majestic, standing figures. The old religious painters made frequent use of this scheme of composition.

Angular composition suggests activity, nervous vitality, and gives to a picture a dynamic quality not otherwise obtained. The purely mechanical reason for this is probably due to the necessity for the eye to travel in short jumps from point to point over the surface of a pictorial composition of this sort, as against being able to wander around leisurely among pleasantly flowing curves. Angular composition will of course be quickly seen to be applicable to bustling crowd scenes, portraits of men, nature in her more violent moods, and even the nude if it is desired to suggest active strength and vitality.

Circular composition might be said to be of a more sensuous character, as curving lines suggest subtle rhythm, the feminine body, grace, charm, and suaveness. This form of composition is especially applicable to portraits of women, the nude in its more charming aspects, and landscapes in Nature's more voluptuous moods.

Line analyses of the composition of three of the plates in this book appear in Figs. 20, 21, and 22, p. 184, Appendix.

CHIAROSCURO All good pictorial composition makes use of the principle of chiaroscuro (light and shade), which is the bringing of light against dark and dark against light in order to gain contrast, pattern, and relief. This is one of the most important elements in all picture making.

PRELIMINARY SKETCHES Obviously, all works of graphic art are built around some fundamental linear scheme. In all probability, every one of the great masterpieces of painting was evolved, sometimes very slowly, from preliminary sketches that were changed, often many times, before the final picture came into being. From their masterful organization of shapes in relation to one another, it is to be assumed that these men wrestled with problems of design and designing sometimes over a period of weeks, months, and even years, until they conquered them. Contrast this with the time spent in composing the average color photograph and it will be seen quickly why many are not so good, especially in the case of model shots where so much depends upon a white heat intensity of concentration behind a ground glass and the inspiration of the moment.

It is for this reason that I think still life offers the best and easiest opportunity for the creation of fine art through the medium of photography.

FINE AND APPLIED ART There is always the distinction between fine and applied art to be borne in mind. Fine art exists for itself alone; applied art as an adjunct to or quality of something else—for a use, as it were. Now, whereas we do not find it hard to accept the beauty of a flower for itself alone, in present-day, mechanical-industrial civilization, people will usually question the use of a picture. Things are estimated much more for what they do or will do than for what they are or will become.

STORY-TELLING PICTURES Unfortunately, very few pictures that tell a story have much significance as fine art. The reason for this is obvious when fine art is considered as a matter of the rhythmic combination of lines, shapes, or forms, and colors in relation to one another rather than in relation to a literary background. Let us suppose that a story calls for the illustration of some episode in its sequence. In order to have the characters carry out the dramatic action, it may be necessary to arrange them in a manner best calculated to express or illustrate the episode, to have them dressed in such a way as to indicate their particular character and against a background fitting the situation. Naturalness and realism are often paramount requirements. Now all this may be fine in regard to illustrating the story properly, but may have no relationship to the pattern arrangement necessary to the creation of fine art. It may be physically impossible to so arrange linear rhythm and arrange and balance masses of tone or color in such a way as to give the composition fine art quality and still successfully tell the story. This is one reason why the Italian Primitives evoke so much admiration. They were able to tell a story, invariably religious, and at the same time make their work fine art—fine enough to be treasured for centuries.

ADVERTISING ILLUSTRATIONS The same condition of the incompatibility of subject matter and the illustration of a point with truly fine design applies equally, or even more, to advertising illustrations. Often the subject matter is unrelated to the background or accessories from a point of view of color,

shape, or aesthetic, not to mention good, taste—but merely from a point of view of sales appeal or promotion. After all, advertising is concerned with sales, not with fine art. Of course, the more successfully attempts are made at combining these two frequently divergent elements the better all around, but this as we know is not the primary purpose of advertising. The Primitives might be termed the first advertising artists, as they advertised the church or religion, but this is an abstract and very different kind of subject from the purely material subject matter of most present day advertising.

ACTION SHOTS It is also usually very difficult to achieve fine art with most action subjects, as their requirements do not lend themselves to the creation of much surpassing mere illustration. The motion pictures are the best example today of trying to do both, and sometimes they come close to succeeding; in fact, sometimes they actually do succeed in combining action with fine art pattern. They have to go to a very great deal of trouble, and quite a lot of time and money are spent to produce these results, however. Most of the art value contained in news shots must usually of necessity be the result of happy accident rather than planned intent.

EMOTIONAL ASSOCIATION OF COLORS The graphic arts and music are the language of the emotions, and through long association of ideas certain colors and certain movements provoke definite emotional responses. Blue being of celestial association suggests tranquillity, peace, purity; and it might also be said to have a religious connotation. Greens and browns are most commonly associated in the mind with the colors of earth and foliage; red with blood, violence, and vitality—and so on. This is a whole subject in itself and cannot be gone into here.

A PICTURE MUST SAY SOMETHING As art is an intellectual as well as an emotional language, the most important thing in any picture is that it have something to say. A picture should do *something* to its beholders; either give them a more complete appreciation of beauty, or, if nothing else, even a good mental kick in the pants.

The law of opposites in its application to subject matter is especially useful for gaining contrast and producing definite reactions and emotional responses in the mind of the beholder of a picture. Opposing large with small, hard with soft, shiny with dull, hot with cold, often enhances dramatic effect. (Examples: a little boy looking at a big elephant; the old familiar sentimental theme of a tiny tot being protected by a big shaggy dog; a nude posed on rocks beside the sea; metal with velvet; cool colors against warm colors; a cold blue steel automatic lying beside a corsage of orchids on a pink satin couch—for that matter a snake on a basket of apples.) However, it must be remembered that the mere combination of such elements does not create good pictures unless the shapes and colors of these objects are related and, in combination, form a worth while pattern arrangement.

Too wide a divergence of sizes may not be related without producing a grotesque effect. For example, you could not make a good picture of an elephant and a peanut, though by changing the whole scale of the composition you could make a picture of a peanut in relation to the end of an elephant's trunk. And furthermore, you can not make a work of art of a work of art—that is, objects that have been consciously created to have art value in and of themselves do not lend themselves readily as subject matter for the organization of good pictorial composition. The simplest objects often have the most interesting forms and provide the best picture material.

RELATIVE VERSUS ACTUAL VALUES Always remember that in all graphic art you are working with relative rather than actual values; that the deepest black it will be possible to obtain is that reflected from your print surface, and the highest light can be no brighter than that reflected by pure white paper. The contrast between the deepest black and highest light possible in Carbro, for example, might be about one to forty or fifty. By carefully observing the highlight on a white metal surface in front of the purest white paper, you will immediately realize how far below in value the paper is in contrast to the highlight. In order to print the highlight in value, the value in the paper will go down to practically half-tone gray. If there are other light colors associated with it, they too will be rendered darker than they are; and dark colors around it will go black and lose color entirely. All this really pertains to lighting, but is touched on here in relation to choice of subject matter that comes within the capacities of the medium.

CAN A PHOTOGRAPH BE A WORK OF ART? For years the controversy as to whether photography is or can be an art has raged, and by way of expressing my opinion on this subject, may I be permitted to repeat something I wrote in the *International Studio* fifteen years ago:

"To appreciate photography one must disassociate it from other forms of art expression. Instead of holding a preconceived idea of art, founded upon painting (painting is cited because, in general, the word 'art' seems to be somewhat synonymous with painting), it must be considered as a distinct medium of expression, and one must first of all realize that it is a medium capable of doing certain things which can be accomplished in no other way. No one condemns architecture because it does not look like a painting or a painting because it is not done in stone.

"Of those who say that photography is too mechanical to produce works of art —and this category includes many otherwise competent art critics—it may be safely said that such an attitude denotes a lack of knowledge. The camera and the various apparatus and materials used in photography are, after all, merely tools, as are the paints, brushes, and chisels of other arts. And the result is bounded, not by the limitations of the tools, but by those of the man.

"If the test of artistic worth is that an object be the means of aesthetic enjoy-

ment, who will deny that through photography such objects may be and have been created?"

FUTURE POSSIBILITIES Whatever many may think, art is certainly important to our development, for as a well-known educator once said, "We would be only two-thirds civilized without art." After color photography has completely solved the problem of reproducing colors naturally with which, due to its youth, it is at present most concerned, we may expect it to branch out further into the realm of pure or fine art by attempting to modify the colors of nature—to organize color relationships or harmonies not merely dependent upon the faithful reproduction of the colors in subject matter. Making use of this point of view will create symphonic color arrangements and evoke moods in those sufficiently mature aesthetically to react to such inspiration and technique.

STILL LIFE

I think that still life presents perhaps the greatest possibilities for purely creative work in color photography, for to put life into still life, into inanimate objects, to create new rhythms and patterns requires imagination. Still life subjects will often reflect a clearer picture of a photographic artist's imaginative vision than landscape work, which is usually more dependent upon the choice of a point of view than upon anything else; or portraiture, in which the photographer must somewhat subordinate his own personality to that of his sitter.

Still life takes up less space and does not move; therefore less light is required. It stays where you put it, so that you can come back to it and make whatever changes in the composition or arrangement, lighting, or exposure, that you have found necessary to a better result. Moreover, it is the cheapest thing that you can photograph if you want to make separations and prints. An ordinary view camera, fitted with a set of gelatin tricolor filters—which are the least expensive—will not only do still life very well, but practically as well as it can be done. As regards lighting, a five dollar set of Kodaflectors, equipped with photoflood bulbs, or a Johnson Ventlite containing a movieflood lamp, and supplemented by a Sunray reflector with a 1000 watt bulb, is all you need to produce a masterpiece. Of course, there will be other times and other subjects that will require more than this, but masterpieces can be created this way. A 4 x 5, 5 x 7, or even a 3¼ x 4¼ inch view camera is capable of producing entirely professional work if equipped with a thoroughly color corrected lens. Unfortunately, as we have found out, this cannot be bought so very cheaply, but in this case there is really not much else to be done about it.

What makes still life good instead of mediocre is the quality of vision and imagination employed by the photographer, and especially his reaction to his subject material. Though this subject may be, from one point of view, much more

impersonal than many others, from still another viewpoint it may be intensely personal and quite a revealing expression of its creator's mind.

A sound knowledge of chiaroscuro and a passionate interest in and reaction to the shape of objects devoid of sentimental association is essential to producing the best results.

INTERIORS AND EXTERIORS

This subject, unless a chance is provided to locally arrange and treat it like still life, presents the same problems as still life without its greater opportunities for the exercise of arrangement and control. In photographing an interior, unless one merely arranges a grouping in a corner, for example, then the choice of an angle from which the room is to be shot is the most important thing. This does not mean that subtle modifications cannot be made in the existing arrangement for better pictorial composition. "Cheating," so called, is often resorted to by way of moving objects closer together or farther apart in order to have them compose better in the picture. This so-called cheating is often needed to counteract the somewhat false perspective of a wide-angle lens, and does not appear unnatural in the print.

With exteriors, the photographer is not afforded the ability that a painter has to regroup shapes in relation to other shapes for better pictorial pattern or design. Therefore, of necessity, the elements of paramount importance involved are accurate observation and the careful choice of a point of view. The meticulous study of lighting conditions present at different times of the day also enters into this matter. For example, a subject may be at its best in a certain season of the year at precisely twenty minutes after eleven o'clock. To insure the best results, prospective subjects should be observed from time to time and at various times of the day and in various qualities of light, until one has arrived at an idea of just what one intends to produce in the way of a finished picture. For example: you might be out motoring some day and see a blasted oak; its bare branches may reach out in rather fork-lightning formation. Now, against a bright, clear, summer sky this subject would have nowhere nearly as much dramatic value as it would set off by the background of some finely shaped, voluminous, thunderhead clouds. The thing to do, of course, would be to make a mental note of this and if possible return to the scene when such weather conditions prevail and a good opportunity affords itself for doing what you had in mind. As most color material is balanced only to bright sunlight between the hours of ten in the morning and four in the afternoon, the introduction of the color temperature meter plus compensating filters makes these more difficult shots much more possible today than formerly. Of course, all of this is not to say that if you have trained your faculties of observation to a sufficient degree of accurate awareness, it will not be possible to frequently come upon subjects ready-made for the camera. This involves being able to see a picture quickly when you come upon it. Usually you will see the best pictures on those days when you have left your camera at home—but fortunately not always.

PORTRAITS

Portraiture in painting is already more or less of a lost art. Without doubt, most of the portraits of the future will be photographic, but not as we know photography today.

In order to do good portraits, it is wise to see your sitters once or twice before attempting the photograph; to see them against the background of their own surroundings; to chat with them, laugh with them or eat and drink with them; but get to know them and be constantly studying them. Be on the alert for characteristic attitudes, gestures, and expressions. Seeing people in their own environment will give you many clues to their habits, tastes, and point of view, and their surroundings often afford both excellent and appropriately characteristic background material for the prospective portrait.

It was once said of a well-known caricaturist that he was able to make pictures of people that looked more like them than they looked like themselves, so much so that his sitters often kept his portraits of themselves out of sight rather than show them to their friends. A slight degree of caricature often intensifies the likeness in a good portrait, and this device has been made use of to advantage by many good painters. Do not for a moment think that a camera lens cannot do the same thing —that is, cannot bore beneath the surface of a personality—if used adroitly by an imaginative, intelligent mind.

In order to do a good portrait, you should be able to pick out a color for a background that harmonizes with the person's personality and a color for him to wear that harmonizes both with the background and with his personality. In other words, to do a good portrait, you must have it planned in your mind's eye first as an arrangement, and unless you can do this you might make interesting snapshots of people but your results won't go much beyond that.

Avoid all fashions that will obviously date your portrait. It takes a certain amount of tact to keep a woman from picking out her latest dress to wear when sitting for her portrait, and to see that she wears an older one that may be more becoming and better picture material. It is a good thing, if possible, to go through her wardrobe and select those dresses which are likely to be most suitable. Then have her try them on until you have made up your mind as to just how you intend posing or photographing her. The color of the dress will often suggest an appropriate background color, and this may often be found right at hand.

In making portraits of men, their extremely unpictorial modern-day business clothes present a real problem. Undoubtedly painters like Holbein, Titian, Velasquez and many others were greatly helped in the pattern arrangement of their portraits of men by the costumes of the period. Today one can have recourse to several ways out, such as trying to get them to pose in just a plain shirt, a dressing gown, a hunting or riding costume—if they go in for that sort of thing, or even in a fancy dress costume that they have worn to some ball; anything at all that has

some fluency of line and color which gets away from the stiff and dull formality of the ordinary business suit. Moreover, white stiff collars and shirts that have a high light-reflective value are always a problem in relation to dark cloth that soaks in light. All of this is not intended to imply that it is impossible to make a portrait of a man in quite formal costume, but rather to suggest that in order to make a really good job of it, it will take considerable thought and intelligent planning to arrive at a result with much semblance of fine art value.

In applying the rules of chiaroscuro and contrast, you would naturally place a woman in a light, figured dress in front of a plain, dark background. A plain dark dress, operating as a single, dark mass or silhouette, as it were, might of course be intelligently placed against a more complicated background.

The simplest poses are the best, and the arrangement of the lines of a composition should be rhythmical and harmonious. Degas was supposed to be one of the great masters of angular composition, and Ingres was certainly a great master of circular composition. It will pay you to study their work, especially that of Ingres, which can be done inexpensively by obtaining little books containing reproductions of their pictures.

Basically speaking, from a character standpoint, men are supposed to be more angular, and women more curving or soft and illustrative of the feminine temperament. In order to arrive at fine arrangements of the figure, a good chair in which to pose your sitter is an invaluable asset. I think the lines of some of the French chairs are often the best for women, as they lend themselves readily to compositions in curves. It is difficult to arrange a portrait, especially in photography, with the same precision possible with a still life, for the personality of the sitter will always intrude upon your most careful reckoning.

Transient expressions do not wear well, and whereas a subtle expression of a smile may be intriguing, most laughing pictures do not go beyond the achievements of mere illustration. What is to be aimed at is a compositeness of expression rather than one clipped off at a moment. For this same reason, most violent action in any of the art mediums ends up by becoming extremely static. The ancient Greeks, for example, in their sculpture, were thoroughly conversant with this truth and therefore suggested action rather than expressed it. For that matter, suggestion is always more potent and intriguing than statement.

Each individual face has its most significant view. The angle at which it is photographed and the direction of lighting are very important and should be very carefully planned. The easiest and quickest way to do this is to hold in your hand a single lamp in a reflector and place it at different angles to the face of your sitter. Study its effect on the features, until you have discovered the best possible manner in which to light the face and to photograph it. There is no set rule for lighting all faces, and each portrait is a new problem in itself.

In a good portrait, one should not feel the medium—that is, whether it is done in paint or by photography—but primarily, and almost to the exclusion of every-

thing else, the personality of the sitter must project itself out to the beholder. I suppose, in order to do really good portraits, one should have a liking for and an interest in people.

About the apparatus to use for doing portraits in color photography, a one-shot camera is best although not absolutely essential, as the old sliding back will also permit of considerable success.

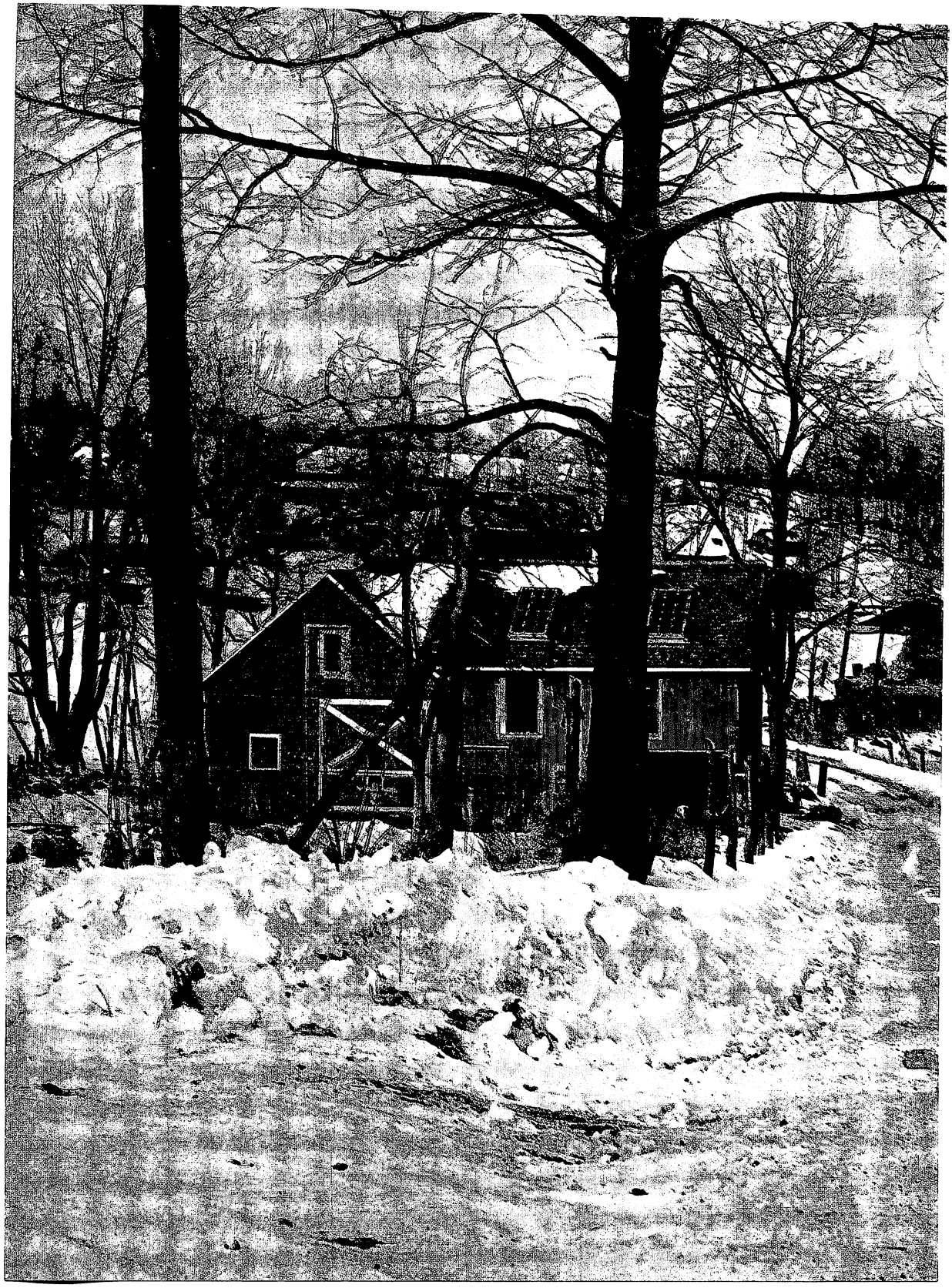
In doing all pictures of people that you expect to reproduce or publish, or that there is any chance of your wishing to use in this way in the future, it is important to secure a release from them, a copy of which is included under "The Nude." Whereas releases are always customary in professional photography with professional models, they are also important in regard to a friend or acquaintance who is willing to allow you to reproduce his picture, and they make for the avoidance of possible future misunderstandings and complications which might arise.

A portrait that is done as a commission—that is, made for a client who pays for it—is the property of the sitter and no use may be made of it, not even for exhibition purposes, without his or her express permission.

The field of portraiture offers a challenge to the ability of future masters of color photography. Flesh tones, not being of an opaque, single-colored character, have always been difficult to reproduce with any degree of lifelike naturalness in color photography. The field for experimentation with slight degrees of localized colored light is wide open. Too much make-up is to be avoided, for although it has been of assistance in commercial work, the overuse of make-up is liable to produce an entirely artificial, grease-paint look and is, relatively speaking, an admission of the photographer's inability to cope with the problem of rendering flesh tones as they are. Although a proper amount of make-up may at times be of unquestioned value, it should not go too much beyond that normally used by your sitters. Elizabeth Arden, Max Factor, Miner, and others all make satisfactory make-up products. Excluding eye shadow and lip rouge, of which a plentiful variety of colors and shades should be on hand, the most necessary thing to have is a foundation or base possessed of as much transparency as possible. Some skins are very much more photogenic than others, and you will find their texture and color far less difficult to reproduce. Every so often you will come upon one that looks very good but photographs very badly. This, and many other problems and their solution make portraiture one of the most intriguing and fascinating of subjects.

THE NUDE

The advantages of photographing the nude are few, except as regards the creation of beauty for itself alone and for aesthetic enjoyment, because nudes have very little, in fact practically no commercial value. The disadvantages are many because it is the most difficult thing to do from every point of view. Good models are hard to find, and all the problems of movement and color reflections are pres-



ent, together with the necessity for fast exposures. In many respects, it is a thankless job which, to do well, costs a lot of money, but it certainly is good training; for, in a sense, just as with painting, if you can photograph the nude really well you should find almost any other subject relatively easy.

As with painting, so with photography to a much greater degree the nude is by far the most difficult of all subjects. Although I have done quite a few compositions of the nude over a period of years, I feel that there is still so much to be learned about it and to be done with it photographically that I have only really begun work with this subject. For those who think that all there is to photographing the nude is to get some girl to stand up in front of a camera lens without her clothes on and fine pictures of the nude will automatically follow, it is to be remembered that there is nothing unusual about the fact that she has a body; every person has one and every main part or trunk of that body has four appended elements—arms and legs, and there's the difficulty. While from one point of view it would seem quite simple to arrange these elements in relation to one another in an artistically significant and appropriate manner, from various other viewpoints it is indeed often quite difficult to make intelligent, not to mention inspired, decisions as to just what to do with them. The primitive African Negroes seemed to be well aware of this problem, and apparently tried to solve it by shortening the limbs in their representations of the human figure—especially the legs, thereby compressing all the elements of the body into somewhat of a single, simplified, solid, cylindrical mass. On ancient Greek vases it may be noted that the Greeks also realized the existence of the same problem of design, and tried to solve it in a similar manner by their diminution of the legs of horses. For, after all, single, solid masses—and this takes us back for a moment to type forms, of which the cylinder obviously is most related to the trunk of the human body—are much easier to deal with in arranging compositions of line and mass than the complicated combination of related forms contained in our anatomy.

The problems of photographing the nude are further increased by the limitations present in photography as regards desired modification of line and form. Painters can not only make numerous preliminary sketches, but can continue to make necessary corrections for better pattern and rhythm in a much more leisurely and controlled manner than is afforded the photographer. His models, often working in the intense heat of photographic lighting and where the very exactness of pose is of paramount importance at the moment of making the exposure, are frequently not subject to as completely controlled arrangement. It is important to remember that the very slightest movement will often entirely upset the most carefully planned linear arrangement and will often lose the bodily beauty of a carefully worked out pose. Just as I suggested in portraiture that you get to know your sitter before attempting to make a portrait, so with photographing the nude you will find it necessary to get to know your model's figure and its possibilities a bit before you will be able to plan compositions or arrangements around this partic-

ular figure; for the best bodies are not perfect everywhere from every angle and much study and thought is necessary to bring out their best points. As with composing other subjects, good compositions of the nude should be carefully planned and built up step by step.

It is probably due to these difficulties, among many others, that most photographic nudes seem to fall into either the catagory of mere academic studies of the figure, or frequently result in rather uninteresting portraits—if we may call them that—of undressed girls. This is also obviously the main reason why the technique of so-called candid shots is not applicable to the nude.

It takes a very finely proportioned body indeed to look well entirely devoid of any assisting elements. The very flimsiest of stage costumes often do wonders by way of giving to a body a semblance of better lines and forms than it really possesses. In general appearance, the figure best calculated to express the ideal of feminine beauty is somewhat high-waisted and long-legged, well-rounded and daintily plump. Such a figure is heavier than that currently accepted as an ideal fashion figure, and is usually liable to look somewhat heavy in clothing, revealing its real beauty only in the nude. For this reason, the trunk or torso of a good sculptor's model is what is to be desired as it is apt to be full, round, and deep-chested—above all, not like many American figures which are considered good. For while so-called beauty contest figures often present good lines as seen from the front, unfortunately they utterly go to pieces from a sculptural or form standpoint when viewed from the side or in profile. The trouble lies in their lack of sufficient depth to provide proper material for any side view compositions of the body. To be sure, the thinner type of figure often looks chic in clothes. But at the moment we are discussing intrinsic beauty, which is founded on the relation of parts or forms to one another, rather than to a prevailing mode. True beauty of the human body is not simply a matter of individual preference either, but in final analysis can be concisely defined by reducing it to this: *a harmonious relationship of proportions with two outstanding characteristics—smoothness and roundness.* The outline of the figure is important and should be possessed of a fine fluency and quality of line and design. Foreshortening is dangerous as it is liable to produce jumbled masses of human anatomy that do not readily explain themselves clearly. There should be a proper relationship between the face, and its expression, and the body in a good nude. Babies are ideal nude studies because their faces belong so well with the rest of their bodies.

Good models are hard to find, for although many models do not mind posing for painting, they object to posing before a camera; when one sees the frequent horrible examples of so-called art photography of the nude, perhaps there is something to be said for the model's point of view. Moreover, working with this subject under the slightest handicap of mental protest on the part of the model does not make for the best results. I think the work of a sensitive, really

creative photographic artist may be influenced by the mental attitude of his model toward her work; any constraint or lack of whole-hearted, enthusiastic co-operation makes this subject more difficult than ever. If one is to get any really good work done, one should have a model who feels thoroughly at home in the nude. The practice of throwing off a cloak just before striking a pose on a model stand, which is current in art schools or when painting for a long time from the same pose, does not work out well in photography because it eliminates the possibility of observing chance poses and chance lightings and making mental notes on them for possible future poses, lightings, and arrangements. After all, a girl who has a really beautiful figure is thoroughly clothed in her own beauty; in fact, it is with the less good figures that one is always most conscious of nakedness.

One good way to go about learning something about photographing the nude is to study the works of the great masters of painting—they all painted nudes, often their wives—and to note carefully how they arranged figures in relation to the background and other surrounding elements of a composition. Above everything, take careful note of their fine pattern arrangements.

If you want to get a really good picture, it will often be necessary for you to go out and carefully hunt out appropriate properties for your composition. The curves of French furniture lend themselves admirably to arrangements of the nude figure, and a chaise longue is an especially valuable asset as it permits of so many charming poses that are independent of the necessity for the amount of light needed for standing figures. It helps a great deal to have plenty of props and materials on hand. Of course, a one-shot camera is the best kind to use if you want to make prints, although making use of the transparency processes permits of greater ease in studio operations.

The human body is a remarkably plastic thing; its contours are constantly changing, and often certain action lines which make a pose really beautiful vanish while you are drawing your plate holder slides on a one-shot camera. To facilitate and speed up exposure, it is desirable, if not absolutely necessary, to work with at least two assistants. There are a great many things that have to be done and checked on very quickly: whether the tone scale is in the proper place with relation to the edge of the ground glass; whether it has a glare or a shadow on it; whether part of the body has an unfortunate shadow on it, necessitating local lighting; whether you have forgotten to pull one of the plate holder slides; stopping down the lens after focusing; setting the shutter; whether the flashlight circuit has been properly hooked in if you are using flash; whether a badly arranged fold that could be improved exists in the drapery in the background; and a hundred and one other things that have to be attended to before the model goes dead in her pose, or some little thing about it has changed thereby losing the whole effect of what you are striving for. As they say of fishing, the biggest fish always get away; so with photographing the nude, the best poses

always seem to get away. You see a perfectly beautiful combination of linear arrangement and lighting, but by the time you have gone through all the preparation necessary for photographing it, the lovely thing you saw is gone and usually impossible to get back.

The best test of whether a skin is photogenic or not is to photograph it, because it frequently will not photograph as it appears to the eye. Above everything else it should be uniform in texture and color, because the camera will pick up variations in color of which the eye is unaware. Such variations often manifest themselves in the final print by the arms and legs appearing darker or redder than the torso, or by a yellowish cast in the abdomen, and consequently out of harmony with the body as a whole. Make-up helps, but it should be used sparingly and intelligently, and I have very rarely resorted to all-over body make-up. Slightly accenting with cold cream the naturally highlighted portions of the body—such as the tops of the breasts, shoulders, arms, thighs, legs—helps to increase the suggestion of roundness and give a certain feeling of life or aliveness to the skin. Due to the intensity of the light sometimes burning out very delicate colors, it may also be found necessary occasionally to slightly enhance the color of the nipples with rouge. However, any overuse of make-up will cheapen the beauty of a fine nude.

While Nature provides hair on certain parts of the body, the prevailing laws in many countries do not recognize or accept its existence, so it is better to eliminate this handicap which will make the picture more difficult to exhibit or reproduce, and will frequently be found to break up the simplified unity of a figure as a whole. Certain modern European painters, such as Henri Matisse for one example, have made good use of this natural hair for design or spotting purposes; and while at times it may have value also in photography for this purpose, nevertheless, photographically speaking, it is rather frowned upon. Bouguereau and many other painters have done their nudes without it, so perhaps it might be better to follow their example.

The nude should be impersonal; a fatal error is to have your model establish a personal or intimate contact with the person viewing the picture. Have a lovely nude model look directly at the camera, especially with a provocative smile or inviting glint in her eye, and you have usually crossed the border between the nude and a particular girl without her clothes on. You might be said to be leaving the world of art and entering the art of pornography. A good nude, as much as possible, should embody a universal concept of feminine beauty, and a great deal of experience with the subject is necessary before one can arrive at much of a result. Not until sufficient familiarity with the nude body causes this subject to be viewed purely abstractly as a relationship of lines and forms of a more or less valuable nature, can photographing the nude be approached with the attitude that makes for successful results.

Of course, it goes without saying that securing a release from a figure model

is just as important, or even more important than it is to secure one from a portrait model. A suitable form is included here:

.....
(place)

.....
(date)

Received from (insert your own name) the sum of ..... dollars ($.....) in full payment for services rendered and all rights in photographs made of me this day by said (repeat your own name) with permission to him, his successors, or assigns to use, sell, copyright, or publish for art or commercial purposes said photographs without further compensation to me, and to which photographs I hereby release all rights, claims, and titles.

.....
(signature)

.....
(witness)

Now that I have given you some idea of the many difficulties connected with this subject, if you still feel that you want to tackle it you may have this to look forward to: If you make a truly beautiful picture of the nude, it will always be a lovely thing and worth having and looking at. If it is really possessed of fine art value and printed in a permanent medium, it will be just as good twenty-five, fifty, or a hundred years from now as it is today because it will not be dated by the clothing of a period and will be a thing of beauty for all time. It is on account of this possible permanence of the subject, and the challenge that it presents to both creative and technical ability, that I have been interested in doing nudes. It has often been said that a work of art is a thing of beauty and a joy forever—and so it is.

5

TRANSPARENCIES

THE transparency processes present less latitude in exposure than occurs in making separation negatives; however, as has been noted, they offer the quickest, cheapest, and easiest method for obtaining color records, especially when traveling.

It is also to be remembered about transparencies that although you will have to hold them up to the light in order to see your picture, they are, within certain limitations, just as good material to send to a photo-engraver for advertising or editorial purposes as any print. For if sufficient skill is employed in the photo-mechanical and hand work done on the reproduction plates, especially with Kodachrome, results comparable to those obtained from the finest prints are quite possible. Magazines and advertisers are not nearly so concerned with immediate results by way of a good-looking print as they are with the finished product in reproduction on the magazine or booklet page.

PRINTS FROM TRANSPARENCIES It is quite possible to do your taking by this transparency method and later make separation negatives and prints from the transparencies. In this case for your final result you are taking a picture of a picture, rather than of the original subject; in other words, you are one step removed from separating the colors directly on the subject itself, which is a more satisfactory way for getting the best results in prints.

Although even quite good prints are possible in this manner, it is to be remem-

bered that a photo-engraver has greater and more varied means of controlling values than the average photographer. For one thing he is working on metal plates. You will not find making really good prints from transparencies too easy, and if prints are desired as your ultimate objective it is wise to make your transparencies as large as possible; and for the best results this also applies to working for reproduction. Both the Eastman Kodak Company and Dufaycolor, Incorporated, will make prints from your transparencies for a maximum of ten dollars for a 5 x 7, and this service is becoming much more widely available and cheaper.

DUFAY VERSUS KODACHROME The great advantage of Dufaycolor over Kodachrome is that you can develop it yourself, and it is quite a simple and short procedure. Dufay is perhaps the easiest color process from which an amateur can get good results if he wants to do his own processing. This advantage is counterbalanced in Kodachrome by the fact that it contains no reseau or color screen, which permits of greater enlargement from it than from Dufaycolor. The image on Kodachrome, produced by the subtractive process, like separation negatives, is a dye image without even the amount of grain in it that is in the silver emulsion of an ordinary black and white; whereas the Dufaycolor image is made up of intermingled dots of the three primary colors: red, green, and blue-violet. Although these occur in the frequency of a million to the square inch and methods have been devised for blurring them in enlargement, you are still enlarging a screened image formed by the additive principle of color photography in which no real yellow color exists, but an impression of its existence is suggested by the eye's inability to separate red and green in very closely intermingled form. A new and much improved yellow has been achieved by Dufaycolor very recently by adjustment in the dyes of the screen base without any loss in light transmission.

Regarding being able to develop your film, if you are really particular and expect the best possible results, as with everything else in life, if you know your business you are much more apt to get what you want by processing your materials yourself. Both Dufaycolor, Incorporated and the Eastman Kodak Company will process their film for you; and as the processing of Kodachrome is obligatory, this service is included in the price of the film. So after paying for your Kodachrome film across the counter of a photographic supply store you are through as far as expense is concerned. However, Dufaycolor, including processing by the company, is cheaper than Kodachrome.

RESULTS OF UNBALANCED LIGHT All transparency materials are balanced to a given color temperature and will render good color reproduction only when the light employed for making the exposure is of the color temperature to which they have been balanced in manufacture. If the illumination is not of this color temperature, and compensation is not made, the resulting picture will be either too warm or too cold—especially with Dufay—in general quality

with consequent false rendering of all the colors. Obviously, adding blue or red to colors will distort them. For a quick graphic example, imagine adding blue to the color of a tomato: it will then become a purplish red or more that of a red apple than a tomato; or imagine adding red to anything as delicate as creamy flesh tones: the person would have the appearance of having just acquired a sunburn.

Correct exposure is very important with the transparency processes, a half a stop over or under making a world of difference—that difference which means success or failure. Underexposure will produce a dark picture with heavily blocked up colors and a bluish cast. Overexposure will produce a thin, faded-looking transparency with a tendency toward a reddish cast. Fortunately, the time has arrived when not only the problem of correct exposure has been solved by means of good photo-electric cell exposure meters, but compensation for varying color temperatures of light is now possible through the use of Eastman's new pocket color temperature meter and compensating filters.

DUFAYCOLOR

SIMPLICITY OF DUFAYCOLOR The reason why Dufaycolor is so easy to operate is that in a sense it is nothing more than a regular black and white process. In other words, the film being exposed through the back on which is coated a screen or reseau of tricolor filters, the light from the lens passing through this screen registers the necessary color filtration or cut-outs on an ordinary black and white panchromatic emulsion. Always remember to load your Dufaycolor film with the film side out, toward the back of the lens, otherwise you will get no color picture. When this panchromatic negative is developed, bleached out, and reversed into a positive, the black and white positive image holds back and lets pass the colors from the screen in proportion to the gradations in the negative—thereby producing a picture in color by means of dots of the three primary colors. If you want to make large prints from Dufaycolor film, it would be better to use no smaller than 5 x 7 inch size; $3\frac{1}{4}$ x $4\frac{1}{4}$ inch will easily make an 8 x 10 inch print without showing the reseau.

For anyone who knows how to develop an ordinary black and white negative, Dufaycolor is a completely fool-proof process. If a mistake is made—for example, insufficient bleaching—the film can be returned to the bleach bath and the mistake corrected without any ultimate loss.

INTENSIFICATION AND REDUCTION Due to the foundation of Dufaycolor being a black and white image, intensification and reduction are quite possible, as with any other silver image.

COLOR CORRECTION BY DEVELOPMENT BY INSPECTION Although time and temperature are, in the long run, the best manner for developing all color negative materials, Dufaycolor offers a further advantage in making

compensation for incorrect exposure possible by means of development by inspection. Inspection may be done hastily by means of a Series 3 Wratten Safelight, or more leisurely by desensitizing the film previous to development.

Another pleasant thing about Dufay is that within eight minutes from the time you start developing, you are through with the business of working in the dark, and within about twenty minutes after taking it into the laboratory you can see what you have in full color.

LIGHTING Dufaycolor standard roll film has been balanced for daylight, and the R series of compensating filters must be used in any other light. There is a filter for flash, one for regular artificial light, and also one for photoflood. By making use of the special blue lamp known as the Wonderlite Dufaycolor Filterflood, no filter is necessary in artificial light, as the light itself is already filtered. Naturally, as in any other color process, mixed light sources should not be used. The film has a speed of Weston 2 in artificial light, Weston 3 with flash and photoflood, Weston 8 in daylight, and Weston 12 with the special Wonderlite bulbs. Generally speaking, Dufay now has the same speed as Kodachrome.

Dufaycolor film comes in all sizes from amateur motion picture size up to 8 x 10 inches, and any camera is suitable. Although loading, exposure—except for the slower speeds—and processing are, relatively speaking, just about as simple as for black and white, the same laws of lighting contrast apply as to those of any of the other color processes. Flat lighting is preferable for the best results.

PROCESSING Processing, which may be done even in a bathroom, is carried on briefly as follows: The film is first developed for five minutes at 65°F. It is claimed that considerable exposure errors may be compensated for by increasing or decreasing the time of development. Then, after a one-minute washing, the film is bleached for four minutes, after which the room light may be turned on, the film washed again for two minutes, and cleared for two minutes in a clearing bath. Then there is another two-minute wash to eliminate clearing bath chemicals, at which stage the image appears clearly in full color when viewed against the light. If the picture appears to have a black deposit on any portion, the bleaching was insufficient and it should be returned to the bleach bath until this black disappears.

After the clearing bath, the second exposure is made by holding the film a foot or less away from a 100 watt bulb. One or two minutes will insure its being properly exposed. In the case of motion picture films, which would be annoying to unreel and expose in front of a light, this second exposure may be eliminated by using a prepared solution known as Si-Mi, which is simply poured on the film after thorough washing following bleaching, and the image becomes redeveloped in this bath. But if you are using cut film, there is no reason why you cannot hold it up to the light for a couple of minutes or so, and then it should be developed in a second developer for four minutes; thoroughly fixed in the fixing bath; washed

for fifteen minutes; wiped off with a damp chamois or viscose sponge; and hung up to dry in a place free from any dust. In very hot weather, a hardening bath before bleaching may be necessary, though not always imperative. It is desirable when loading, unloading, and handling the films for development to do so with white cotton gloves to avoid possible fingermarks. This practice is in current use in the Dufaycolor Company's laboratories. When the films are dry, for purposes of examination and handling it is best to put them in transparent negative envelopes as they are damaged easily, and thumb marks are extremely undesirable if you wish to use the transparencies as a basis for reproduction or to print on paper.

VIEWING DUFAYCOLOR There you have your Dufays finished and ready to be viewed by daylight, to which the film is originally balanced. Only with this light source will colors appear in their true correct values. A good viewing light is made out of daylight coming through a sheet of ground glass, or if you are looking at many of them often you might get one of those special Wonderlite, blue-daylight filter bulbs and put this behind the glass.

If your Dufay pictures were made for reproduction purposes, there is now nothing left to do but send them on to the photo-engraver and he will make his separation negatives from them for the four color half-tone letter press process. If they were made merely for your own amusement, or as a record of your family or garden or something of that sort, then by using the special Dufay printer—which you can get from the company—you can make your own separation negatives and end up with a print in either Chromatone, Wash-Off Relief, or Carbro.

TYPES OF DUFAYCOLOR FILM, COLOR TEMPERATURE BALANCE, AND FILTERS There are three types of Dufaycolor film: the standard roll film and film pack for amateurs, balanced to roughly 5200°K. and requiring no filter in daylight; the daylight type cut film balanced to roughly 5200°K.; and the artificial light type cut film balanced to 3400°K., which requires filters under all conditions including daylight.

When it is desired to use the daylight cut film for other light sources, the D series of filters is used: 2D for photoflash; 3D for photoflood; 4D for Mazda.

When it is found necessary to use the artificial light film for other light sources, the PF series of filters is used: 1PF will bring the film to the color temperature of the regular daylight type; 2PF for photoflash; 3PF for photoflood; and 4PF for Mazda.

For separation negatives, either by contact or projection, the P series is necessary: 1P red, 2P green, 3P blue. These will all need various multiplication factors: with Ilford Soft Gradation Panchromatic Plates, for example, they are: red multipled by 1, green by 4, and the blue by 12.5.

SEPARATION BY CONTACT Separations may be made by projection, if it is thought desirable to raise the size of the image in gradual stages, as it were, for obtaining a quite large print. Generally speaking, however, it is better to

make the separations by contact, which eliminates any possibility of their being out of register. Plates are always to be preferred to films for separation negatives as, on account of their rigidity, there is again less chance of imperfect registration.

As good a way to proceed as any other is to place the Dufay film transparency on a sheet of glass in an ordinary printing frame, lay an Ilford Soft Gradation or other panchromatic plate over it, and clamp them together with the spring back of the printing frame. For a printing light with which to make the exposure, simply use your enlarger with the amount of light controlled by the diaphragm of the lens and the rheostat. Over the lens you will have to attach the three special Dufaycolor Separation Filters, which—although like the usual tricolor filters—are not the same red, green, and blue as used for making ordinary separation negatives in your camera. The cutting of the spectrum in these filters has been worked out especially in relation to the colors in the Dufaycolor transparency. The exposures are made by simply laying the printing frame in the center of the enlarging board and making three negatives through the three filters. It is important that they register, so provision must be made for returning the printing frame to exactly the same place on the enlarging board. See "Separation Negatives," Chapter 7; Enlargers in "The Laboratory," Chapter 6; Making the Black and White Positives in "Printing Processes," Chapter 8; and Lenses in "Cameras and Camera Equipment," Chapter 2. All the same laws—color-corrected lenses, voltage control, etc., apply to separations made by projection from Dufaycolor or Kodachrome film.

If you have not color patches to guide you attached to the gray scale which appears in the Dufaycolor transparency, it is very important to mark these separations Blue, Red, Yellow printer, etc., as you go along, so that there is no chance of their becoming mixed up later. For, although it is usually relatively easy for the experienced eye to determine which printer is which by a knowledge of the colors and cutouts of the subject, one can be mistaken, especially with certain colors in connection with Dufay. I have made this mistake myself, much to my sorrow, and therefore most emphatically urge you to be careful in marking your separations when they are made. Of course, as in the making of all separation negatives, the gray scales should match in all three negatives, and the blue filter (yellow printer) negative should be developed for the usual fifty per cent or sixty per cent longer time than that given to the blue and red printers. For detailed description of procedure, consult "Separation Negatives" and "Printing Processes," Chapters 7 and 8 respectively.

CURTIS DUFAYCOLOR PRINTER For facilitating the making of separation negatives up to 4 x 5 inches from Dufaycolor originals, there is the Curtis Dufaycolor Printer. In it there is a special "cold" light under controlled voltage; a sliding frame containing the color filters with openings of various sizes—which eliminates the multiplication factors for the different filters and permits of giving the same exposure for all three when used with Defender XF Pan film;

a platen; and special matt film insuring the best possible contact and elimination of the possibility of Newton rings. By making use of this printer, the matter of separating Dufaycolor is rendered somewhat easier and more convenient.

This is especially true for anyone wishing to do all his color photography by means of small size Dufay prints, for in a laboratory equipped with the proper voltage-controlled enlarger for making enlarged positives and separation negatives, the equipment necessary for doing this work is already available except for the special filters necessary; and surely the matter of multiplying the basic exposure by the different times necessary for the three filters should be no great hardship. However, it is a very convenient instrument to have on hand if one is doing much of this sort of work, and as it contains a voltmeter and rheostat as well as other advantages, if these are not already on hand, it would cost about as much or more to go out and buy it and put it together in a homemade manner which would probably not be anywhere near as good. It sells for around fifty dollars. Before starting to expose any Dufaycolor film, get *The Dufaycolor Manual* from your dealer or from the Dufaycolor Company, Inc., 30 Rockefeller Plaza, New York City. It costs only a quarter and is certainly well worth its price.

KODACHROME

INVENTION AND NATURE OF PROCESS Kodachrome was invented by Leopold Mannes and Leopold Godowsky, sons of the well-known musicians by those names; they themselves are musicians. It was perfected with the assistance of the facilities of the research laboratories of the Eastman Kodak Company. It is entirely different in functioning from any of the other transparency processes, as instead of being additive it is a subtractive process.

Three thin emulsions are coated over one another on a single film-stock base. Each one of these is sensitive only to that portion of the spectrum corresponding to one of the tricolor filters. What really happens is that a set of separation negatives is made all together on one film. These negative images are bleached out and redeveloped into positive images, but, when this is done, instead of being merely developed to a black and white image as is customarily done by reversal, they are developed with dye couplers which have the faculty of coloring the image as they develop it. In other words, they develop the positive images in the three primary printing colors, red, yellow, and blue—and so is formed the color picture. It will be easily realized that to develop three superimposed emulsions, separated by a thin layer of gelatin, each entirely independent of the others, and to color each of these independently, is a rather ticklish technical procedure. As it requires the most rigid exercising of a variety of controls, it becomes a machine proposition away beyond the capacity of the average photographic laboratory. Therefore all Kodachrome must be sent back to Eastman in Rochester for processing. Probably in time, for the sake of convenience, as conditions warrant there will be other processing stations to take care of certain territories.

TYPES AND SIZES Kodachrome comes in four types: Regular, for sunlight; Type A, for incandescent light or a color temperature of 3200°K.—for motion picture size film suitable for miniature cameras like the Contax or Leica; and Professional either Daylight Type or Type B, also balanced to incandescent light of the same color temperature, which comes in cut sheet sizes 3¼ x 4¼, 4 x 5, 5 x 7, and 8 x 10 inches.

SPEED The motion picture size Type A Kodachrome has a speed of twice that of the Type B Professional film, being Weston 8 for daylight and 12 for artificial light, as against 4 and 6 for the cut sheets which are of moderate contrast and reasonable latitude, thereby permitting of more latitude of exposure and better rendering of color.

QUALITY OF LIGHT NECESSARY If any of the types of Kodachrome are used in lighting of a color temperature to which they have been balanced in manufacture, no filter will be necessary for the best color rendering; but if they are not, as with all other color materials, compensation will have to be made. For example, subjects illuminated by light from a blue sky on a clear day will have a distinctly bluish cast. All you have to do is to look at a mountain lake shielded from the direct rays of the sun to get this in mind clearly. Happily, the color temperature meter will take care of this situation for you and will be of great assistance by informing you of the filter needed to restore balance when working in various kinds of light.

EXPOSURE Eastman recommends the use of Portrait Panchromatic Film as a check guide to exposing Kodachrome. The former should receive one-half to one-third the exposure of the Kodachrome. For example: in using a Graflex magazine every other film loaded might be a Portrait Pan, which can be kept and processed in your laboratory while the Kodachrome is being developed in Eastman's Laboratory in Rochester. When you get the Kodachrome films back, the gray scales in them can be compared with those in the Portrait Pan films.

DARK, MEDIUM, AND LIGHT SUBJECTS The Eastman Kodak Company, in its excellent little pocket exposure table booklet entitled *How to Expose Kodachrome,* makes two things very clear. First that fifty per cent more exposure will be needed for a medium-colored subject (think of half-tone gray on the tone scale) than for a light-colored subject (think of white on the scale), and double the exposure correct for a light subject will be necessary for a dark subject.

BACK, SIDE, AND FLAT LIGHTING It takes four times the exposure of flat front lighting to obtain adequate exposure with back lighting and twice as much with side lighting.

EXPOSURE AND THE WESTON METER It has been noted that overexposure of color material dilutes all colors with white and produces a thin,

faded-out picture. Let us see how this applies directly. If you take a Weston reading on a large white square of paper with a small black square in the center, you will find this reading very different from one on a large black square with a small white square in the center. The Weston will make compensation for the large dark area and indicate a greater exposure. Now if you apply this to color by changing the black to a deep rich blue, you will find that giving the exposure indicated by the large white square will register the small blue square in its proper color, and that the same exposure will render the large blue square in proper color. If you had given the large blue square the exposure indicated by the meter for it, you would have overexposed it (diluted your color with white), and the Kodachrome result would have been a much lighter blue than the actual color photographed. Of course, this would apply similarly to a blue room or any other deep-colored room, etc. Therefore, when gauging exposures for Kodachrome, some people prefer to take their readings on white, such as a white sheet of cardboard. Some people like to take them on gray, such as a half-tone gray, but Mr. Rockwell of the Weston Electrical Instrument Corporation says that the best possible exposure on any subject is arrived at by measuring individually the lightest and the darkest part of the subject, or in color, the brightest and the deepest color and taking the reading midway between the two measurements as the one to use for exposing. The best way to do this is to sight over the meter on distant objects as you would with a gun, and where conditions permit of approaching closer and the objects are smaller, on account of the 60° angle taken in by the meter, whatever the width of an object the reading should be taken at a distance equal to its width. When using the meter for color work, values in the subject should be kept within the A and C positions on the dial.

The new Weston Master Universal Exposure Meter Model 715, combines the practicality of the old 650 Model with a much greater degree of sensitivity, and contains certain modifications or changes in construction which ensure its remaining in perfect adjustment over a longer period of time than that which could be depended upon in connection with the old meter. This exposure meter is ultrasensitive in low light and reads from 1/10th to 1600 candles per square foot and film speeds of from 3 to 800.

Due to its restricted 30° angle of vision, which is half that of the average camera lens, sharply directional measurements are possible from the camera. This directional feature combined with the extra sensitivity make it ideal for color photography, in which the taking of local individual measurements is often so necessary.

When positives are made from separation negatives, compensation is made for the variance of the exposure value of different colors by balancing the printing exposure until the lights and the darks print in their proper values. As this is impossible in a transparency, where the balance is established at the time of exposing, the matter of correct exposure determines the final result.

COMPOSING PICTURE As with all other color materials developed in developing hangers, when exposing Kodachrome always allow at least a 3/16 inch safe edge all around your composition. This will take care of the possibility of edge fog and scratches due to contact of the edges with the hangers.

VIEWING Whatever the light employed for taking the picture, to see the colors correctly in Kodachrome film, it should be viewed in high efficiency tungsten light of a color temperature of 3200°K., for if the film is viewed in daylight, for example, the colors will appear too blue and not at all correct.

Eastman makes a Kodachrome viewer in the form of a light box with a ground glass and an illuminant of the correct color temperature. So sensational has been the increase in popularity of Kodachrome for advertising as well as editorial purposes, that many of the agencies have installed these Kodachrome viewers where they are always readily available for the inspection of films.

SILVER REFLECTORS The use of silver reflectors is clearly indicated in outdoor figure compositions, as the shadows from bright sunlight turn into opaque black masses when prints are attempted. Celotex board, which is light and rigid, provides a good backing for crumpled tin foil, which may be affixed to it with rubber cement.

PRINTS FROM KODACHROME Kodachrome has a long range of contrast and is capable of very beautiful results. Excellent separation negatives for prints are possible by using a "cold" light (daylight fluorescent tubes with a color temperature of 6500°K.), and narrow cut L., F. and N. filters which are Wratten Nos. 50, 29, and 61 respectively. Some people prefer the C4, No. 49, to the L, No. 50. All the same rules of balance and registration apply as those to which all color separation negatives are subject.

One thing must be always kept in mind about a print in contrast to a transparency: the range of tones possible on an opaque reflecting surface such as paper is much shorter than with a transparency. A matt print may have a contrast range of from one to thirty or forty, whereas a transparency may have a range of from one to two hundred. With a print, the highest light possible is that reflected from pure white paper, whereas with a transparency the light itself produces the highest light. Therefore, due understanding and consideration should be accorded the necessity for transposing values, and transparencies made with prints in mind should be lighted as flat as possible to reduce the contrast range to within narrow limits—somewhere within the capacities of printing processes. If you don't do this you may get beautiful, brilliant Kodachromes with a long contrast range, but you won't be able to make prints from them having anything resembling the quality of your original.

CURTIS KODACHROME PRINTER The Thomas H. Curtis Laboratories, who manufacture the printer for separating Dufaycolor, also make a sim-

ilar printer for making separation negatives from Kodachrome. It is similarly priced and may be bought unassembled for considerably less money. Complete instructions for assembling come with the parts.

I have seen excellent Wash-Off Relief prints made from Kodachrome originals, and although some people believe that Kodachrome lends itself more readily to Wash-Off Relief printing than to other printing processes, I do not see just why such should be the case.

FILTERS FOR KODACHROME When using the professional daylight type film with sunlight, no filter is required. With an overcast sky, the No. 1 Wratten filter may be used, and for subjects in the shade or receiving only diffused daylight, the Wratten No. 1 or No. 2A are recommended. The Eastman Company strongly advocates the use of a daylight type film for daylight and a type B film for artificial light rather than trying to rebalance from one to the other by means of filters. Flashlight being considerably bluer than 3200°K. light to which the B type of filter has been balanced, requires the use of a filter, and the Wratten No. 2A is indicated as being the proper one to use.

I would strongly suggest that the prospective user of Kodachrome obtain and study carefully all of the booklets on the subject issued by the Eastman Kodak Company before attempting exposures.

PART TWO

WHEREIN WE BECOME MORE TECHNICAL

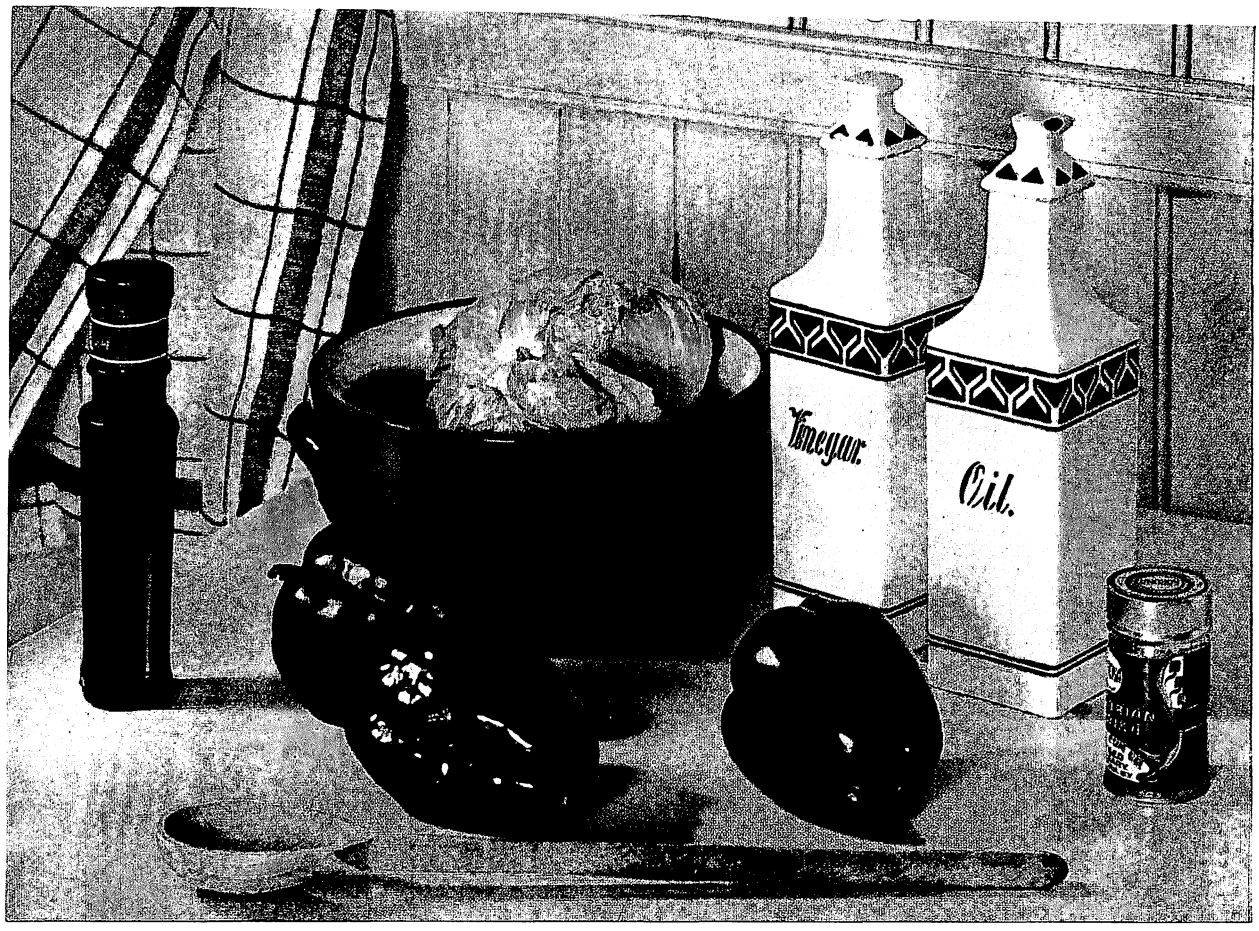
6

THE LABORATORY

AS EXACTNESS of timing and temperature is of vital importance in the processing of all materials having to do with color work, certain equipment must be on hand in any color laboratory to provide and maintain a definite working standard. In order to keep track of time, clocks are needed; to keep track of temperature, thermometers are necessary; and to maintain it, water jackets. Water jacketing all solutions is advisable. Although it is not imperative, air conditioning to permit of maintaining a given atmospheric humidity and temperature throughout the year is ideal for color processing, and puts production on an easier and more reliable basis; 70°F. is the practical limit for any of the color printing processes, and 60°F. with a humidity of 50 per cent is best for Carbro, for which a cool room is really necessary for registering.

The laboratory for Carbro should be divided into two rooms—one for bromide work and one for the part of the work requiring a low temperature. This is the best way to lay out any laboratory for color anyway. An idea of the appearance of a small laboratory and necessary equipment for color work may be had from looking at the illustration in Fig. 13, p. 183, Appendix.

TRAYS AND GRADUATES FOR ONE PURPOSE The laboratory should be kept clean, neat, and orderly. It has been said that cleanliness is next to godliness, and this is certainly true in color photography. Furthermore, it is preferable to have certain graduates, trays, and tanks for certain processes and


Vinegar.
Oil.

chemicals; and though it is possible to interchange their use if they are thoroughly washed, it is better not to do so. Certainly if much color work is done it will be found in the long run that it is better business and more convenient to have a sufficient number of graduates and trays on hand to permit of always using the same one for the same purpose, thereby eliminating any chance of contamination.

CHEMICALS Chemicals should be of the best—at least of U.S.P. standard, and once a source of supply has been settled on, stick to it. I have always used Mallinckrodt's and Eastman's for most purposes, and for certain others I go to Eimer & Amend, the big chemical house in New York, and buy only the best quality.

NEGATIVE DEVELOPMENT

TANKS Laboratory equipment divides into two main groups: that for processing negatives, and that for processing prints. In developing negatives, trays or tanks are required. Tanks of stainless steel or hard rubber are commonly used, in which the negatives are supported in chemical-resisting, metal, developing hangers. As it is important to use and maintain exact temperature of the developing solution, a little immersion heater for raising the temperature will be found a handy adjunct to any dark-room. The temperature of the developer may be lowered by setting the tank either in the refrigerator or within a larger tank filled with ice and water.

When the temperature has been brought to 70°F., which is now becoming accepted as best for developing high-speed negative materials, it must be maintained with the greatest accuracy. This is done by having the tank set in a water jacket, which consists of a larger tank in which the water has also been brought to 70°F. and which contains a sufficiently large volume of water to preclude any possibility of change within the time required for development.

It is much better to keep all negative processing solutions at 70°F. than to plunge relatively warm negatives into an icy fixing bath and from that into warmer wash water, or vice versa; in other words, complete standardization of the temperatures of all baths should be maintained together with complete accuracy of timing of all operations. All good color results are dependent upon this, and obviously only with completely standardized conditions is it possible to go back and check on causes of variance or failure and make necessary adjustments or compensations for them.

TIMING CLOCKS AND THERMOMETERS Timing clocks will be needed, at least one of each of the second timer and the interval timer variety; also accurate floating thermometers—one for the tank itself and one for the water jacket—for here again checking and rechecking is of utmost importance. When buying thermometers, be careful to select those whose readings coincide; in other words, whatever number are used in the laboratory, they should all register the

same at a given temperature. A wall thermometer and humidity meter complete this part of the equipment, and a metronome may be found convenient for timing short operations in the dark.

DRYING EQUIPMENT Viscose sponges will be needed, kept immaculately clean and in the best condition, for wiping plate and film surfaces before putting them up to dry; also, plate drying racks and at least one electric fan.

GRADUATES AND SCALES Of course, accurate graduates must be on hand. The 64 ounce Pyrex type is rather expensive, but nevertheless necessary for mixing developers at 125°F. An extra 64, two 16, two 8, and even a couple of 4 and 2 ounce graduates make good working equipment.

The Eastman Studio Scale is quite satisfactory for measuring small quantities of chemicals, but a larger kind should be available for weighing the sodas, especially in making several gallons of stock solution. Although certain color laboratories use only the metric system for weighing and measuring, as it is considered the most accurate, in practice this is not imperative.

FAUCETS AND RUBBER HOSE All faucets should be preferably of chromium, because it seems to be the only metal that can stand laboratory chemical fumes without turning black—that is, if you care about having a neat, shiny laboratory.

All rubber hose used for filling graduates and for other purposes should be of the black, free-of-sulphur variety; red and other colored bathroom type hose is not satisfactory. The extremely flexible hose such as Eastman supplies with the tray siphon washer is the best and most convenient to use. This variety can be bought from a good chemical house that caters to scientific and chemical laboratories, such as Eimer & Amend, New York.

VIEWING BOX A viewing device consisting of a suitably ventilated box with a frame supporting a piece of opal glass, capable of taking three 5 x 7 inch negatives in a row, or perhaps six which will permit of comparing two sets of separations, is necessary for examining exposures, balance, contrast, or details with a magnifying glass. This should be illuminated with either one or two Lumiline tubular lamps to insure similar illumination of all the negatives placed thereon. By making a hinged cardboard mat or covering for the opal glass, which will block off all the light except that coming from a 5 x 7 inch opening, this box may also be used for retouching.

WATER It has been found that one of the most mysterious chemicals of all, and of which there is not nearly as much known as might be, is water. Recently scientists have discovered "heavy" water, and still more recently they have come to believe that instead of one kind of heavy water there are about five. Pure water, free from sediment, especially lime, is very much to be desired for any of the color printing processes. Sediment will cause scratches in the images. In Chromatone,

Carbro, or Wash-Off Relief printing, lime will cause loss of detail in the highlights, and other troubles. If the water is not very pure and clean, use a Berkfeld filter on the tap.

Quantities of distilled water may frequently be necessary, and will often clear up technical troubles in the printing processes, and the best and cheapest way to order this is in five-gallon bottles. If these bottles are placed on a shelf above the work table, a tube run through the rubber stopper down to the bottom of the bottle, and a hose attached to the other end with a clamp suitable for shutting off the flow, a convenient method of filling graduates and trays will be provided. This also applies to bottles of developing solutions that are being used in any great quantity. Although to the uninitiated, distilled water is thought of as a constant, in point of fact it varies with its sources; therefore it is well always to obtain it from the same source of supply.

An abundant and dependable supply of hot water is necessary, especially for Carbro. Somewhat less is needed for Wash-Off Relief, and none for Chromatone.

PRINT MAKING

ENLARGERS Almost any enlarger is suitable for color work if it gives perfectly even illumination over the entire print area and permits of sliding around the negative carrier in all directions in order to register each subsequent enlargement on the preceding one. Unfortunately, very few come ready-made with this capacity. Therefore, when selecting an enlarger, choose one that will permit of remodeling the negative holder to this end.

A condenser type enlarger will permit of greater enlargement with greater sharpness, and give more brilliant results from less contrasty negatives. Among the better ones of this type are the following: a German auto-focusing machine called the Phoenix, which is rather difficult to obtain at present but probably can be ordered through the importer, Medo Photo Supply Corporation, New York; the Optikotechna enlargers made in what was formerly Czechoslovakia and imported into the United States by Chess-United Corporation, New York; and the Simmon Omega—probably the best American-made enlarger, but which is not made at present larger than 4 x 5 inches. So much for condenser type enlargers.

While the Elwood, made in Indiana, U.S.A., is not, strictly speaking, a condenser type, as it does not make use of glass condensing lenses, it produces practically the same results by means of a highly polished parabolic reflector for concentrating the light rays. It is a good value for the money, and quite satisfactory for color work after necessary modifications of the negative carrier have been made. This may be done by reducing the original thickness of the sides of the wooden negative carrier by about a half-inch, thus creating enough space to allow for necessary sideways movement for the purpose of registration. Attaching springs at the four corners to the under side of the negative carrier will hold it in place with a slight pressure after its position has been established.

The Crown enlarging camera, made by Eastman, is also excellent for color work because it permits of moving the negative carrier in all directions. For an illuminant, some good color workers use a box of bulbs burning tip down and placed so close together that they form an even illuminating surface above the opal glass. The Crown, which used to be known as the Folmer & Schwing, may also be purchased with a mercury vapor tube illuminant. Mercury vapor tubes and argon tubes give softer results, greater speed with little heat; they are less subject to fluctuations in voltage and quite satisfactory when working from separation negatives, but of no use for making enlarged separations from Dufay or Kodachrome, for—here again—we are dealing directly with color and the light source, a mercury lamp, is monochromatic. For the same reasons, well color-corrected lenses will be needed for this work. J. G. Saltzman, Inc., New York, makes an excellent enlarger of the mercury tube variety, and an argon tube may be bought to fit the Elwood enlarger.

VOLTAGE CONTROL As it is of the greatest importance that all enlargements in color work be timed with complete accuracy, voltage control is essential. It will be obvious, for example, that when the correct printing times for a given subject have been found by means of test strips, and the enlargements for these same times are made, it will be impossible to match the test strips if the voltage in the enlarging lamp has subsequently gone up or down—thereby giving more or less exposure within the same time limit. Therefore, it is imperative to run the enlarging line through a voltmeter, which will tell you what your current is doing, and a rheostat, which will enable you to make it do what you want. The Weston Electrical Instrument Corporation of Newark, New Jersey, manufactures good voltmeters.

The best way to go about installing voltage control is first to get the voltmeter, find out what happens over your line, and see if there are not some times of the day or evening when the voltage remains constant for a reasonable length of time for working. If this is the case, you may not need the rheostat; if not, it will be necessary—and as with it you can only decrease voltage, not increase it, if the voltage seems to average around 118 it will be practicable to do all enlarging at about 110 volts.

Well-equipped, large-scale laboratories have installed rather costly automatic voltage regulators that even take care of momentary dips in voltage and provide freedom from the necessity of keeping a hand on the rheostat handle during the whole time of exposure. Vibration during exposure is to be guarded against.

CHECKING ALIGNMENT AND PAPER HOLDER Check your enlarger carefully to see if it is level and in exact parallel with the enlarging board; that all parts of it are in perfect alignment; and that the negative carrier, lens board, and paper holder are in complete parallel. Otherwise your prints will be out of focus in spots.

To insure maintenance of alignment, the paper holder board used for enlarging should really have a lead plate screwed onto the bottom of it. It should have rubber feet to insure staying where it is put for some time, and should even, preferably, be screwed or clamped down when it has been decided just where it should be placed for the composition of a particular set of negatives.

Lock all adjustments before commencing work, and keep them locked until the whole set of black and white positives has been made, and preferably until you have three color images that may be combined—at which time you can check the color balance. If any correction is to be made, you can then go back and make another or other enlargements which will fit into register with the set.

TRAYS Only the best quality enamel over iron, porcelain, or glass trays are suitable for color work. If there are any exposed metal surfaces, ruinous chemical reactions will take place, even more so than in other photographic work. The trays should be of ample size to prevent crowding and uneven covering of the prints with solutions. Trays should be washed out immediately after their use and kept spic and span in, so-to-speak, medically clean condition.

About a dozen trays will be sufficient for carrying out comfortably any of the three color printing processes described in this book. They may be classified as follows:

Developing tray, for either Chromatone, Wash-Off, or Carbro, in which there is taped across the far end and legible in the dim red light, an Eastman stirring rod thermometer. This tray is floated in a water jacket in the form of a larger tray, also containing a taped thermometer in the lower right side. Use waterproof, medical tape.

A tray for a shortstop bath, and a tray for the fixing bath, which should be of the deep, five-gallon variety, if many large prints are to be made. This larger tray will obviate the necessity of frequent mixing of the fixing bath, and keep it from becoming alkaline too quickly.

There should be a washing tray that is large enough to permit the prints to spin around freely, propelled by the inflow from an Eastman Tray Siphon Washer, which seems to make the cheapest, most practical and efficient washer of all for the purpose.

About eight trays will be needed for the bleaching, washing off, rinsing off, and dyeing baths for the Wash-Off Relief process; about six for the soaking, sensitizing, hot water development, and transferring in the Carbro process, and only about three for Chromatone.

Prints that stick together in a bunch will not wash properly. If the slightest bit of hypo is left in them, very unpleasant troubles will ensue; so it pays, until you have found out just how long it takes to wash prints under your own conditions, to hypo test them. (See Formula in Appendix.)

LIGHTS You will naturally never get good, clean color if the darkroom

light is unsafe and fogs the paper. It is wise to make a test for this by covering half a sheet of bromide paper and leaving the other half exposed to the darkroom safelight for several minutes, and developing it to see if there is any noticeable change between the halves.

A Brownie Safelight containing a Series 3, green, Wratten filter and a 10 watt lamp will serve for negative development, but this should be switched on only momentarily to consult the clock. A Wratten Safelight with a Series 0 screen in it, also containing a 10 watt bulb, is suitable for developing enlargements because it is better not to take chances with the possibility of fogging materials. It is much better to err on the side of too little than of too much light; but paper fogging tests will let you know just how far you can go.

A long Lumiline-type light or fluorescent tube is advisable for comparing, stuck up on a sheet of glass, the three, wet, black and white prints necessary to any of the printing processes. It will insure seeing each one in exactly the same quantity of light, as with the negatives. You should also have one 200 watt, blue-daylight bulb for viewing prints, and for other purposes.

CLIPS AND WIRE Plenty of wooden clips for hanging up prints, wires strung up for suspending them, and at least one electric fan will be needed for drying prints.

SQUEEGEE For the Carbro process, some sort of automatic squeegee or wringer is much better than hand squeegeeing, even if a two-bath bleach is used. The #320 Anchor Brand Penn Easy Photo Wringer is the right kind to use. Of course, hand squeegees will be required as well, and for Wash-Off Relief, a special one for the purpose made by Eastman. Besides these, there will be needed a special soft rubber roller for Carbro, which can be obtained from the Gevaert Company in New York or certain printing supply houses. A quantity of lintless photographic blotters and some large sheets of plate glass will also be required.

WORK BENCHES Regarding the general layout of the laboratory, the so-to-speak tank-like work benches should be at least 30 inches wide if large prints are contemplated, and the linear footage of this tank should be about 24 feet. This does not have to be constructed in a straight line, but can go around two or three walls of a room, with space clear in the center for operating. Sufficient pitch for drainage on the bottom of this tank is necessary to prevent over-humidification of the laboratory. Above this work bench, shelves for bottles and other equipment will be found convenient, and on the wall, a room thermometer and humidity meter. Wide-necked bottles from one to three gallon capacity, with rubber stoppers should be available in sufficient quantity, and some solutions require storage in brown light-proof glass. Waterproof medical tape lettered with India ink is practical for labelling them.

STORAGE OF MATERIALS Storage in a cool dry place has always been advocated for all photographic materials. The basic reason for this precaution is that in photography one is always dealing with gelatin in some form or other. Gelatin, as you probably know, is a substance that comes from stewing down animal tissues. It is an organic or life substance, not mineral product. It forms a colloidal solution in water, can absorb moisture, become soggy and turn rancid, and is very much affected by both temperature and humidity. This is the reason why the old platinum prints were much more permanent, because their image was not in a gelatin emulsion coated on paper, but in a basic metallic image in the paper itself. However, considering what a tricky substance gelatin may be, all in all it works out very well if certain precautions are observed.

Heat will cause the plate emulsions to ripen more quickly. This is especially true of the ultra high-speed emulsions necessary with one-shot color cameras, and too much dry heat will cause the rolls of pigmented paper used for Carbro to become brittle and crack when you attempt to unroll them and cut off sheets. It must be emphasized: that as well as a knowledge of how to use photographic materials, the proper precautions and conditions for their storage is a matter of considerable importance, and will greatly influence their performance.

TRIMMER A good twenty inch, all-metal trimmer is a requisite. That made by the Eastman Kodak Company is the best I know of; it is self-sharpening, retains perfect alignment, and will last indefinitely if not abused. Over a period of years I have found a multiplicity of uses for it, and would not think of operating a laboratory without one.

CAUTION Although you may have gotten away with careless technique in black and white, if you attempt this sort of thing with color you will find out in very short order that you simply will not get results. Careful attention to a number of little things makes for success in color photography. Remember, color printing processes can be temperamental even when used under ideal conditions, so why make matters harder for yourself by lack of attention to what at first may seem relatively trivial details? Probably the most important requisite of darkroom technique—and its value and absolute necessity cannot be overemphasized—is a passion for cleanliness and standardization. Checking and rechecking everything is necessary to arrive at more complete standardization, which in turn makes for easier production in color photography.

7

SEPARATION NEGATIVES

SUPERIORITY OF GLASS PLATES Whereas film may be used for making separation negatives, there is no question that glass plates are better, because they eliminate possible buckling and uneven shrinkage, which is liable to occur either from the heat of an enlarger or when film dries.

KIND OF PLATES TO USE Plates for color work must, of course, be panchromatic—that is, sensitive to all colors, and they should be backed. Some of the best for the purpose are Tricolor Panchromatic Plates, Wratten & Wainwright Panchromatic, or Hypersensitive Panchromatic, and Super Panchro-Press, all made by the Eastman Kodak Company; also Ilford Soft Gradation or Hypersensitive Panchromatic Plates made by Ilford Ltd. in England. For separation negatives for still life subjects that are made in a view camera, my own preference is Ilford Soft Gradation Panchromatic Plates. They have a Weston speed rating of 12 in artificial light, and are very consistent in coating, speed, and contrast characteristics—in fact, they are most dependable plates. They keep very well in the holders, but, for best results, it is better never to leave the latent images on any plates too long before developing them.

LOADING THE PLATE HOLDERS It is very important that color plates should be free from thumb marks. Before loading a number of plates, the hands should not only be washed with soap and water, but Oakite may be used to advantage as it is a grease solvent and will leave the skin as dry as paper.

As dust is greatly to be avoided, it will be well to tap each plate once or twice on the table before loading it into the holder and then to blow it off before inserting the slide—that is, if you can be sure to blow dry. The greater the precaution taken at this time, the less tedious spotting of the negatives will be necessary later. Granted, this is merely good black and white technique, but bear in mind in color there will always be three plates to spot instead of one and this is not always so easy to do, especially when they have been developed in a fine grain developer which puts a glaze on their surface almost like that of the glass back.

TEST EXPOSURE FOR BALANCE You have the right kind of camera, tripod, lens, filters, filter holder, and plates loaded in the plate holders, and you are all ready to shoot. Let us imagine you are in an empty white room face to face with a new acquaintance, which will later be found to be your best friend —the tone scale. You are now about to embark on your first solo flight in the science and art of making color separation negatives. You may as well make up your mind now that you will have to cultivate this acquaintance assiduously or you will never be able to make any good color prints, for, as we have seen in "Color and Photography," it is the key to the balance imperative in a set of separations. It is often called the gray step wedge, gray scale, and scale of grays; but I prefer the term gray tone scale because in a sense it corresponds to scales in music from the point of view of their being the basis of one's technique, which must be mastered before going on to the pleasures of playing charming compositions. Perhaps you will remember that those dilettantes who wouldn't practice scales never got to be very good pianists. A really good artist is always a good craftsman or technician as well. For the moment, forget all about the pretty girls, arrangements of flowers, or exciting human interest pictures you might like to take, and look at what at this stage of the game is by far the most important subject you could possibly photograph.

The tone scale should be evenly lighted without glare or reflection with similar lamps of equal wattage in similar reflectors at the same distance on either side—in short, the technique of copying is what is necessary. To avoid getting a false reading from the light reflected from the white walls, it is well to have the tone scale largely surrounded with dull black.

Set your exposure meter window to the rated speed of the make of plates you are using. In the case of Ilford, as I said before, it is 12. Read the top, bottom, and middle of your tone scale and estimate the best average exposure. Estimate your exposure on the full side, as you are quite close to your subject—which gives the lens stops a somewhat different rating. Now make out a data card and pin it up beside the tone scale (see next page).

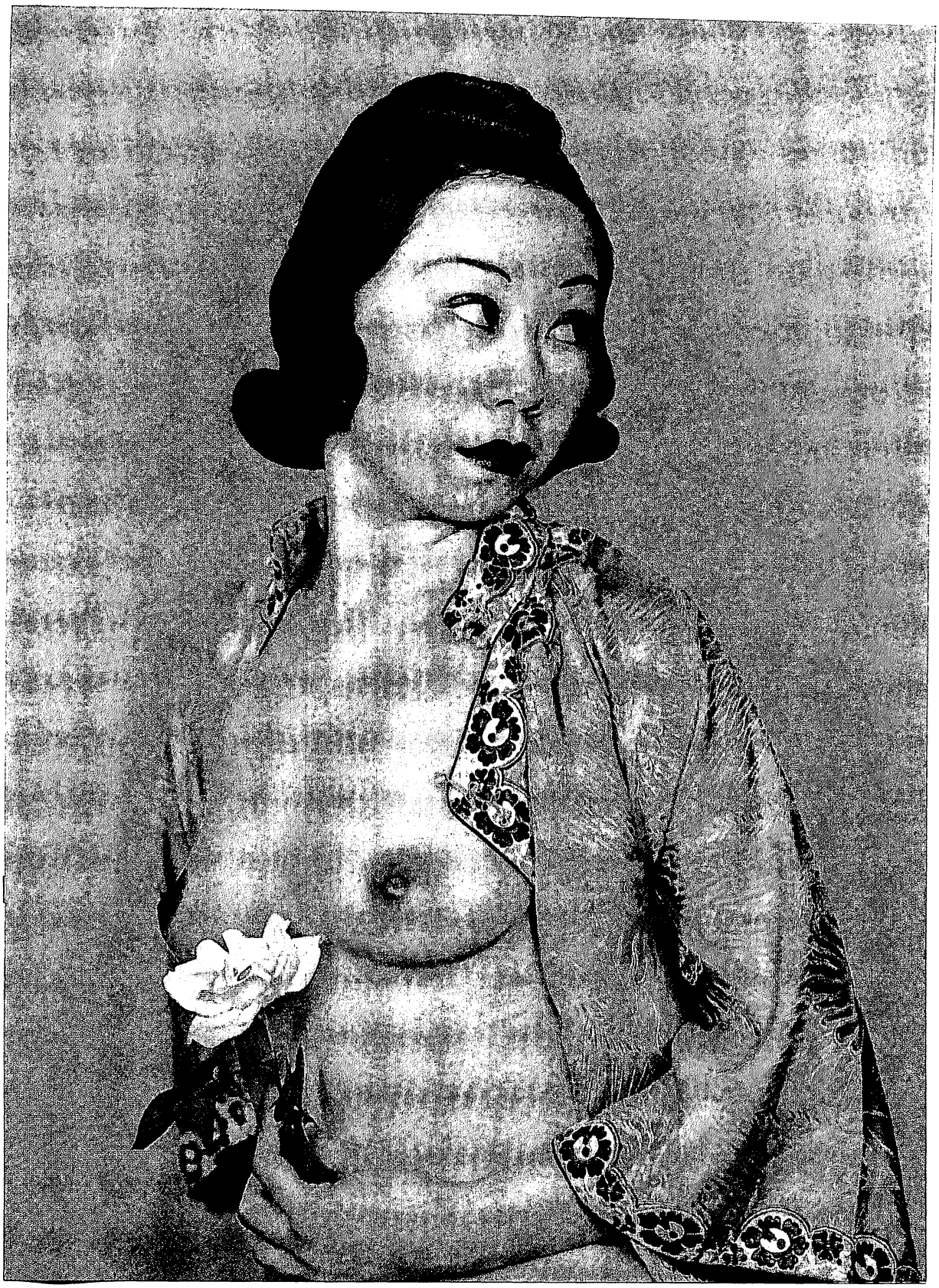
This is an example of how to keep a record of all facts pertaining to the exposure and development of a test set of separation negatives. With this system you have all the information on your plates, and there is therefore no chance of

mixing up matters and making mistakes when you get these negatives out, sometimes months later, for checking purposes. Of course, the information set down will naturally vary with the kind of light, make of plates, or kind of developer that you elect to use. Results may vary due to different emulsion numbers of the plates or age of lamps—which should be new for tests, so you see it is important to keep most careful track of everything.

SET NO. I				
				.....(as this is your first set of separation negatives)
4 new No. 1 photofloods, 1 ft. distant				.....(or whatever you are using)
Weston (12), Apo-Tessar, F/45, 2 sec.				.....(or whatever make of lens you are using)
Ilford S. G. Pan Plates Emulsion No. 8648 B				
Filter Factors:	Red 4 x	Green 6.5 x	Blue 4.5 x	.....(found in slip enclosed in box of plates)
Multiplied by 2 sec. exp.:	8 s.	13 s.	9 s.	
Developed D-76, 65°F.	14 m.	14 m.	22 m.	.....(the blue filter negative is usually developed from 50 per cent to 60 per cent longer than the other two to compensate for lack of contrast characteristic of this filter)

Focus on the tone scale so that it appears in the center of the ground glass, the top and bottom ends coming within not less than a quarter of an inch of the top and bottom. Never work closer than 3/16 of an inch from edges of plates on account of the possibility of edge fog and distortion of color rendering.

EXPOSING Pick out the set of plate holders marked (1), properly identified for color; insert the plate holder marked Red; see that the red filter is in place before the lens; turn on the second timer clock; open the shutter for eight seconds and close it exactly on the fifth second; change to the green filter; insert the second plate holder marked Green, and expose it for exactly thirteen seconds. Repeat this process with the blue filter for its proper exposure time, and with the correspondingly-marked Blue plate holder. Shut off the clock and the lights; take the plates to the dark room and agitating every three minutes develop them for the times previously calculated and noted on the slip.



TANK OR TRAY PLATE DEVELOPMENT All development should be done by time and temperature and the times and the temperature (65° or 70°) should be exact. Again, in the slip included in your box of plates you will find developing times indicated.

Color plates may be developed either in trays or in a tank. If trays are preferred, arrange three trays diagonally on a suitable support like a board, so that all three may be rocked in exactly the same way together. The reason for rocking the trays diagonally is to avoid flow marks and subsequent uneven color. Plates are generally developed in Core plate developing hangers in tanks. Core plate hangers, once popular before films took the place of plates, now have to be especially ordered from the Eastman Kodak Company. Film hangers are not so satisfactory for developing plates, as the perforations around the edges are liable to leave streaky development markings around the edges of the plates where the tone scale is often placed—thereby falsifying its values.

HOW TO DEVELOP THE NEGATIVES The best way to develop negatives for color work is with mechanical agitation, which insures identical and even development of each and every plate; but as this machinery would have to be made to order and is beyond the scope of most photographers, a satisfactory hand method follows: Let the light from a Brownie Safelight equipped with a Series 3, green, Wratten Safelight and containing a 10 watt bulb shine on the face of a Kodak Timer clock. This timing arrangement should be several feet away from the developing tank. Close at hand to where development takes place, place an Eastman Interval Timer, which may be reset in the dark to tick off a measured amount of time and then ring a bell. (Two minutes if the plate development times are short, as with one-shot camera plates developed in DK-50, which take around seven or eight minutes each, or three minutes if the development times run to fifteen or twenty minutes.) You will have to keep track of what plates are where from the time you start until the very end, so group your plate holders in a definite order to which you will always adhere.

Shut off all light; unload your plates, placing them in the developing hangers all one way; for example: in the case of a portrait, with all the heads up or down so as to insure similar development. The developer at the top of a tank is faster than at the bottom. Then the hangers should be arranged in the following manner: blue, which are stood up against the wall first, green in front of these, and red last. You now have your plates facing you in the hangers in the order in which they were exposed through first red, then green filter, and finally blue filter.

TIMING Go over to your Kodak Timer, which was set at five seconds before 60 (corresponding to 12 o'clock), and press the lever to start it. You will then have these five seconds grace to locate and crank up your three-minute Interval Timer, gather all the plate hangers together, and lower the lot slowly and

evenly into a one to three gallon tank containing D-76 (Formula in Appendix), a suitable developer for Ilford, or DK-50 recommended for high-speed, for one-shot camera plates. (Edwal-12 is to be preferred especially when large prints are desired from small plates as it gives much finer grain.)

AGITATION As soon as you have lowered the plates into the hard rubber or stainless steel tank, agitate them violently for two or three seconds to disperse or shake off any air bubbles; then, taking them in order, quickly raise each plate in its hanger out of the developer two or three times, agitate it again briskly in the developer, and leave the plates entirely alone until your Interval Timer bell rings. There should be at least a half an inch of space between each plate. This bell will let you know that the first three minutes have gone by. First, reset the clock; then without delay push all the plate racks to the back of the tank. Now, one at a time, pull them toward you against the developer which, by flowing away from their faces, will insure even agitation of the developing solution. Each plate must have identical treatment or the color rendering may be streaky, uneven, or otherwise faulty. Again leave them entirely alone until the bell rings, when they must be agitated again in an identical manner. Continue to repeat this procedure until the fourth bell rings, when you will know that twelve minutes have elapsed. Then you had better switch on the green safelight and take a look at the Kodak Timer to check up. (Interval Timers do not always measure time as accurately as second timers.)

SHORTSTOP At the end of the predetermined fourteen minutes, lift the red and green record plates out of the developer, give them a quick and thorough rinse in cold water which will stop development; preferably—although this is not absolutely necessary—stop them in a shortstop bath (Formula in Appendix). Then put them in the fixing bath—(Formula in Appendix), agitate by pulling them forward against this bath as you did in development, and leave them to fix. All this must be done in less than three minutes because, remember, your Interval Timer clock will ring again within this time, and to insure identical contrast, all the plates must be agitated in an exactly similar manner at exactly similar intervals.

Check up on your second timer when you think the right amount of time has gone by; and a few seconds before twenty-two minutes shut off the green light illuminating this clock, go over and lift out your blue filter (yellow printer) plates and immerse them in the fixing bath in the same manner as you did the red and green.

Now, there's nothing hard about this. It's just knack and technique that become automatic with practice, but you will have to step pretty lively in the case of developing, let us say, four sets of one-shot camera plates where the development times may vary for all three of the colors and be only half a minute apart. If the red filter plates are due out at seven and a half minutes, you have been agitating,

as described before, every two instead of every three minutes, and you have only one-half a minute leeway before the green filter plates must come out of the developer—on the dot. Within that half-minute you will have to lift out the four hangers containing the red filter plates, rinse them and get them into hypo and not be a moment late in removing the green filter plates, which are due out on the eighth minute. Not more than two dozen plates at the very most should be developed in one gallon of developer, as partially exhausted developer acts more slowly and perfectly developed sets of separations depend upon absolute standardization of the strength of the developer, developing times, and all procedure. Fresh developer for every set of plates is really best of all.

FIXING The plates, of course, should be thoroughly fixed, and the old rule for this still applies: leave them in the hypo for as long again as it takes for the milky appearance to disappear from them. Fifteen minutes is a good, safe time for Ilford plates with a good fresh hypo solution, but some of the higher speed plates may take a bit longer if you want to be sure.

WASHING Wash the plates, suspended in their hangers, for a half-hour in running water. Your Interval Timer comes in handy for this because you can just set it to ring in half an hour and go off to do something else while they are washing. Remove the plates from the wash water, one at a time, hold them under a softly-flowing water tap and gently swab them off with the best quality medical cotton. (Cheaper cotton is liable to have in it bits of grit from the cotton seed which may scratch the tender emulsion badly.) Let them drain off in a drying rack until you have put the third plate up to dry, when it will be time to wipe off all the surface moisture on the first plate with a viscose sponge (be sure of the best quality), or chamois. This will prevent uneven drying or drying marks that distort color. Repeat with all the rest of the plates.

DRYING Leaving at least an inch between each plate, put them up in front of a fan with their edges pointing toward the draft. If the room is not very dry and warm, you can accelerate their drying by blowing the breeze of the fan over the top of a little electric stove—but do not place the stove too near the negatives and do not blow too much heat on them.

IRREGULAR BALANCE AND CORRECTING IT In color work it is imperative that the exposure and contrast of all three separation negatives be as nearly identical as is humanly possible. This means that the difference between the density ranges of the three negatives of a set should be no more than five one-hundredths, and within closer limits if possible. If you can produce negatives in which each separate step in all three tone scales is identical in all three negatives, you will have the best kind of plates for printing purposes that it is possible for anyone to make. Such a result is arrived at only by correct exposure produced by using the correct multiplication factors for the three color filters, and developing each

negative for exactly the correct time to produce identical contrast. As we have found that a scale of neutral gray tones reflects and absorbs equal quantities of the spectrum, and if correctly exposed will photograph the same through all three filters, we can make use of this tone scale for ascertaining the difference both in exposure and development present in any or all of the three separation negatives.

DENSITOMETER Checking exposure and development of a set of separation negatives is done by means of measuring with an instrument known as a densitometer. Although good color prints are possible without densitometric control, you will not be able to get much control over the color printing processes without the use of some form of this instrument. The Eastman Kodak Company manufactures an excellent transmission densitometer, but this is a rather expensive bit of apparatus (about $160). There is also a model which measures not only the amount of light that the various parts of a negative transmit, but also the reflected light from a paper surface, this instrument costs more than double this price. A much less expensive instrument of both models is manufactured by the International Research Laboratories of New York. A home made one, originally suggested by Mr. Rockwell of the Weston Electrical Instrument Corporation will serve —and as my model, though not fancy, is entirely practical, it is shown in Fig. 6, p. 180, in the Appendix.

As you know, the photo-electric cell in the Weston meter is sensitive to light, and with it you can measure the intensity of light coming through different parts of your negative as well as you can measure light anywhere else. Since in separation negatives you are dealing with color, the density of a given portion of your plate will vary considerably in the three negatives. Therefore, the gray scale included in your original composition is used for this measuring because it has, or should have, a record of an identical amount of the three colors. The light transmitted from the No. 2 photoflood bulb through the 3/16 inch hole in the top of the box, through the various steps of the gray scale to the sensitive photo-electric cell will cause the needle on your Weston meter to register various amounts of light. In the table on p. 180 in the Appendix the readings of the Weston meter needle are converted into negative densities.

By means of this handy little device and the table, you will be able to check up very satisfactorily on the exposure, development, and balance of your negatives. The goal to be aimed at is to have each step of the gray scale read the same in all three negatives. If the thinnest steps of the negative gray scale read the same in all three negatives, it will indicate that your exposures are well balanced, but if one of them has a different density, you will know that this plate has received either more or less exposure than the other two—depending upon whether the density reading, from the conversion table, is higher or lower. My preference is for negatives that read, on the graph (see p. 181, Appendix), from around .25 or .30 at the lower end of the tone scale to about 1.15 or 1.20 at the upper end; if you subtract

the smaller from the larger figure, you will see that this produces a density range of .9. This is a very suitable range indeed for Carbro, but for Wash-Off Relief a density range of .6-.65 is better, and for Chromatone a range of .75 is best. If the densest step of the gray scale reads differently in one of the negatives from the reading of the others, it is an indication that this negative was incorrectly developed—either over or under, depending upon whether the figure is higher or lower. The color results of incorrect development and unbalanced sets of separation negatives are illustrated in the "Color Chart" in the Appendix.

GRAPHING The results of under- or overexposure, or under- or overdevelopment may be conveniently set forth and checked on paper by means of graphs. They are easy to make and the way to go about making them is as follows: In any stationery store you can buy ordinary graph paper that can be fitted into a loose-leaf notebook. Number the divisions on the bottom from one to eight or one to ten—depending upon the number of steps in your gray tone scale. Number the left side vertically in similar divisions according to the number of lines on the graph paper. (See Appendix, p. 181, Figs. 7-10).

Fig. 7A shows in graph form proper exposure and proper development of separation negatives. You will note that the reading of the tone scale starts at a density of .30 and goes up to 1.20, producing a range of .90. From a set of separation negatives of this sort excellent and brilliant color rendering may be expected for Carbro printing. Fig. 7B shows how underexposure and underdevelopment appear in graph form. The density range of this negative, or these negatives, is .40—which is much too flat. It will produce dark, muddy colors. Fig. 7C shows underexposure and overdevelopment, which has produced a contrast of 1.30. This is too contrasty for good results from most of the printing processes, for detail in the highlights will mean black shadows lacking detail; or, if compensation is made in printing for the shadows, the highlights will not have printed through and will be empty. Fig. 7D shows overexposure and underdevelopment, with a range of .30. This again will produce too flat a result and colors will lack contrast, snap, and brilliance. Fig. 7E shows overexposure and overdevelopment. The shadows will be too light. Consult the Color Chart for under- and overexposure.

Fig. 8 demonstrates graphically the results of improper development of a set of separation negatives. Due to the overall difference of .60 in the range of the three negatives, no good color print is possible from this set of separations unless the red and yellow printers are brought up to the blue by intensification. This would then give the whole set a density range of 1.40, very high for good color printing.

Fig. 9 shows the graph of a set of separations used to produce the Carbro print of the snake and apples entitled "Waiting for Eve," Plate 13. This set is about as nearly perfect as is generally made, and in this illustration is shown the method of keeping data records in a graph book.

Fig. 10 shows why it is possible to produce a satisfactory print from a set of

separations in which one of the plates has had a much greater exposure than would have been correct, but development has been satisfactory. This printing possibility is due to the fact that the density ranges of all three plates is nearly identical, having a variance of only .04, and that the curves of the overexposed and properly exposed plates parallel each other fairly well. The exposure for the red filter negative was correct, as indicated—but actually in the excitement of fast operation a mistake was made, and this negative was overexposed; it probably received a full second.

By taking the reading of each step in the tone scale with the densitometer, you can plot curves that will show you graphically just what is happening to your negatives by way of exposure and development. In the long run this is the quickest, easiest, and best way to arrive at making good, well balanced sets of separation negatives that will yield consistent and dependable results in color printing.

Now, going back to your original first set of separation negatives: After you have measured all the steps of each of the three gray scales and jotted these figures down in column form on paper, as observed in the illustrations in the Appendix, they may be transferred to graph form—wherein you will be able to see just how far and in what way they depart from a perfect set, and also what is to be done about it. Then you will return to the studio, remove the data card, make out another one with indicated changes in exposure and development of any or all of the three plates, and rephotograph the tone scale with these changes. This you will continue to do until you arrive at a set of negatives that will read close to that shown in Fig. 9 in the Appendix. These filter factors, exposure times, and times of development will then hold good as long as you continue using the same emulsion number of the same make of plates with the same kind of developer. When you buy a new lot they should be tested before using. It will be apparent that a set of separations made with two emulsion numbers is quite out of the question, and it is even preferable to make each set with plates all out of the same box. As you will note, this is one of the instances where checking and rechecking comes into the picture of color photography. You will remember my mentioning Ilford plates, and this is why I like them: over quite a long period of time, under all kinds of weather conditions, and from emulsion to emulsion I have found that they remain remarkably consistent.

INTENSIFICATION Although it is much better not to have this sort of thing happen, if any of the three negatives in a set of separations lacks the contrast necessary to being in balance with that of the rest of the set, intensification may be resorted to as a way out. I have obtained excellent results with the least trouble by using a preparation known as Victor Intensifier, which comes in a powder to be mixed with water, keeps well for an indefinite period of time, works very rapidly, simply, and easily. One has only to immerse the dry negative in this intensifying solution, rock the tray for anywhere from thirty seconds to a minute or two,

wash for ten minutes, and put it up to dry again. When doing this, I lay the negative from the set to which I think it will be easiest to match the one to be intensified on the sheet of opal glass of the viewing box described in "The Laboratory," Chapter 6, so that the light comes through it. This I have on hand right beside my intensifying tray, and from time to time during the course of intensification I lift the negative out of the tray and compare the gray scale in it very quickly with that in the other plate on the illuminated opal glass. Matching with any degree of accuracy in this manner takes a very good eye and some practice. There is one thing to watch out for in connection with Victor Intensifier: washing seems to bring up the intensification somewhat stronger—especially if any degree of intensification has been employed, so this has to be allowed for. When intensifying two or three negatives, all at the same time, in order to achieve similar results it is important to rock the tray containing each plate in the same manner. You might try alternating three times sideways with three times up and down, counting one, two—one, two—etc. A metronome will come in handy for this sort of thing. This method of intensification is not the most scientific, but it has served me very well at various times. Regarding the more scientific manner, which is a two-hour proposition and supposed to be the nearest to perfectly proportional, see the Appendix.

Intensification is rarely as satisfactory as making a perfectly balanced set of separation negatives in the first place, but it is a very helpful way out in time of need.

RETOUCHING A certain amount of color retouching is sometimes necessary in separation negatives in the interests of truer or more perfect rendering of certain colors in the finished print. Certain colors, due to their position in the spectrum, the limitations of sensitized materials, and also those of the three-color process in general, are very difficult to reproduce. (Not much more than about ninety per cent true reproduction of color may be expected from any three-color process). You can help this matter out a bit by adroitly and carefully retouching the negatives.

Take, for example, dark greens as in the leaves of certain plants. They often do not color separate well enough, with the result that there is too much red in them, which is liable to make them somewhat black, or lacking in greenness. By means of a certain black dye liquid, which photo-engraving supply houses and the Devin Colorgraph Company sell, certain areas like this may be held back in printing. This dye may be diluted with water to any degree of transparency or lightness, and by the use of soft camel's hair brushes of various sizes with which to apply the dye, you can hold back, to any desired degree, the printing of these areas in the green filter or red printer plate. If a large area is to be held back, it will be found necessary to soak the negative in water for ten minutes, wipe its surface dry with a viscose sponge, and then apply your black dye lightly, gradually building up the desired density. Coccine, made by Agfa Ansco, may be used, but as it is red, estimating its effect is more difficult.

VALUE OF WELL BALANCED SEPARATIONS A good set of separation negatives, whether it be made from a Dufaycolor or Kodachrome film, or directly from the subject, is absolutely essential to the making of any kind of good color print. With a good set you can do wonders, and everything will go along much more smoothly and easily; with a bad set you will always be working at a great disadvantage—that is, unless the set is so bad, so very far out of balance, that it cannot be printed at all. So I assure you that no matter how long it takes you, time spent in getting negatives as nearly perfectly balanced, from the point of view of exposure and development, as possible will not be time wasted, and furthermore, a great deal of time will be saved when making the print.

8

PRINTING PROCESSES

WE HAVE found that all prints on paper require separation negatives which contain in minus or negative form the three primary colors: red, yellow, and blue. We are now about to print by enlargement, positives in these three primary colors which we will eventually superimpose in register and thereby produce a natural color print on paper. We have also found that these separation negatives should be in as nearly perfect balance as possible, and how to bring them into balance; and also, that it is necessary to include the gray tone scale or step wedge in them; and here it will come into practical use in making the black and white positives from which color prints may be produced by either the Chromatone, Wash-Off Relief, or Carbro process. As the same technique of enlarging applies to all of these currently popular processes, it need not be treated of separately in relation to each process.

ARRANGING THE COMPOSITION Depending upon the subject of the picture, select that negative which will give the nearest approximation to a black and white rendering of it. In the case of a portrait we may prefer to use the green filter negative, which is the red printer, as the red filter negative which prints the blue produces only a very pale, unnatural-looking result by which to judge flesh values. If the subject is a landscape, the blue or yellow printer may be preferable.

Arrange the composition as desired on the enlarging board, focusing the image to a size at least one-half inch smaller all around than the size of the paper or film

used. This will provide a quarter-inch margin on the printing material, which is important in all color processes. If possible, include the tone scale so that it comes against this white margin—as it is convenient to be able to compare it with pure white. When the picture has been properly composed, lock all adjustments on the enlarger to avoid any movement during the running through of the set of three prints.

METHOD OF REGISTERING IMAGES As it is necessary to register the image projected from each of the two succeeding plates over that of the first or blue plate image of a set, provision must be made for doing so. This is done by fastening a piece of white cardboard firmly onto the enlarging board with Scotch mounting tape; after the composition has been arranged by projection on this cardboard, make on it a careful and accurate pencil drawing of some of the chief directional lines of the subject, especially in the four corners.

MAKING TEST FOR PRINTING DEPTH Check the voltage on the voltmeter, and if it has been found necessary to control it with a rheostat, bring it to exactly 110 volts. Stop down the enlarging lens to F/11, which is a good all-around stop for enlarging. Too small stops are liable to bring the grain of the ground glass diffusion screen into focus. Then, if Chromatone is being used, take a strip of Chromatone paper—if Wash-Off Relief film, a sheet of Kodabrom No. 3, which has about the same contrast as that of the relief film—and if Carbro, a sheet of the special bromide paper—and expose it for printing depth as follows:

Make a graded exposure by covering most of the paper with a piece of cardboard and giving the first part five seconds, the next ten, the next fifteen, twenty, twenty-five, thirty, etc., and develop this in the previously prepared developer which is exactly 70°F.—the standard temperature for all three processes. This temperature should not vary a half-degree, and may be maintained by the water jacket system previously mentioned in Chapter 6, "The Laboratory." When the correct exposure has been ascertained, make a whole print for this time and study it carefully, and also study the tone scale. The accepted rule for depth of printing in all the processes is to print deeply enough to produce a slight veiling over the highest lights, such as a white collar, or the lightest step of the tone scale if there are no whites in your composition and the tone scale has received the same intensity of light as the rest of the subject. This light veiling is necessary as there is a slight subsequent loss in the processes. In order to find out if this has been done correctly on a white in the composition, bend the back of the paper over and lay it against this white for comparison with pure white. Prints may be keyed either lighter or darker, according to taste; darker prints are apt to be richer if color in the deeper shadows is not lost, and prints that are too light are liable to look like washed out water colors or hand tinted black and white pictures.

After estimating the printing time or correct exposure for one of the three

negatives, it will be necessary to bring the printing times of the other two into proper relation with it. This may be done in either of two ways:

VISUAL COMPARISON METHOD OF DETERMINING PRINTING EXPOSURE FOR RED, YELLOW, AND BLUE PLATES Now, all that is required is to find out what exposure times will produce three identical gray scales from the three separation negatives. Cut up a few small pieces of paper large enough to print the scale only. First make a print of the scale contained in that negative selected for ascertaining printing depth, and for the time found necessary to produce this depth. Then make prints from the other two negatives of greater and less exposure than the determined time. These should be only one or two seconds apart. For example, if thirty seconds was established as the printing time for the blue printer negative of a particular subject to provide the depth and quality desired in the final print, then exposures of the tone scales on the red and yellow printer negatives may be made of twenty-four, twenty-six, twenty-eight, thirty, thirty-two, thirty-four, thirty-six and thirty-eight seconds (mark the time given on the back of each strip, also B-blue, R-red, Y-yellow, etc., for identification)—all of these being developed at the same time, together, to avoid any chance of the slightest variation in the temperature of the developer, which would falsify their depth or contrast. After two to three minutes in the fixing bath, lay them out on a sheet of white opal glass and compare them in a good light to ascertain which time for the red and yellow printers will most closely match that previously established for the blue printer. It takes a good eye and a bit of experience to match three of these perfectly, but an experienced eye can see in printing a difference corresponding to three per cent in the difference in contrast of negatives. A surplus of five per cent of any color will ruin a print, and two per cent will falsify the perfect reproduction of color. If a perfect match is not secured, then further test strips will be necessary, always developing with them a single print of the tone scale from the negative to which the others are to be matched.

DENSITOMETRIC METHOD OF DETERMINING PRINTING EXPOSURES FOR RED, YELLOW, AND BLUE PLATES The alternative method for determining the correct exposures for the three negatives makes use of the densitometer. The operation of the home made type is described here.

Before commencing, the Weston meter needle should read 100 without any negative in place. The opaque part of the tone scales gives the smallest Weston reading, usually from 2 to 6. The thinnest part of the scale gives the greatest Weston reading, usually from 45 to 65. Take the meter readings of the most opaque parts of the scale, which might be for a set of negatives: blue—4, red—5, and yellow—3.2. Find the exposure by test for the keying negative.

Let us say it is a portrait and the exposure for the green filter negative or red printer has been found to be thirty seconds. Now, to find the exposure times for

the blue and yellow printers, use proportion as follows: In order to find the exposure for the blue printer—30 : 4 :: B : 5. Multiply the extremes, 30 x 5 = 150, and divide by the known mean, which is 4, 150 ÷ 4 = B = 37½, or the number of seconds required for a balanced exposure for the blue printer. For the yellow printer: 30 : 3.2 :: Y : 5, which is 150 ÷ 3.2, which equals 47, the correct exposure for the yellow printer.

Make tone scale prints for these times which will be within five per cent, either over or under, correct, and then check by matching by eye. It will sometimes be found that an addition or subtraction of from one to two seconds may be necessary. Bear in mind that one and one-half seconds equal five per cent of thirty seconds.

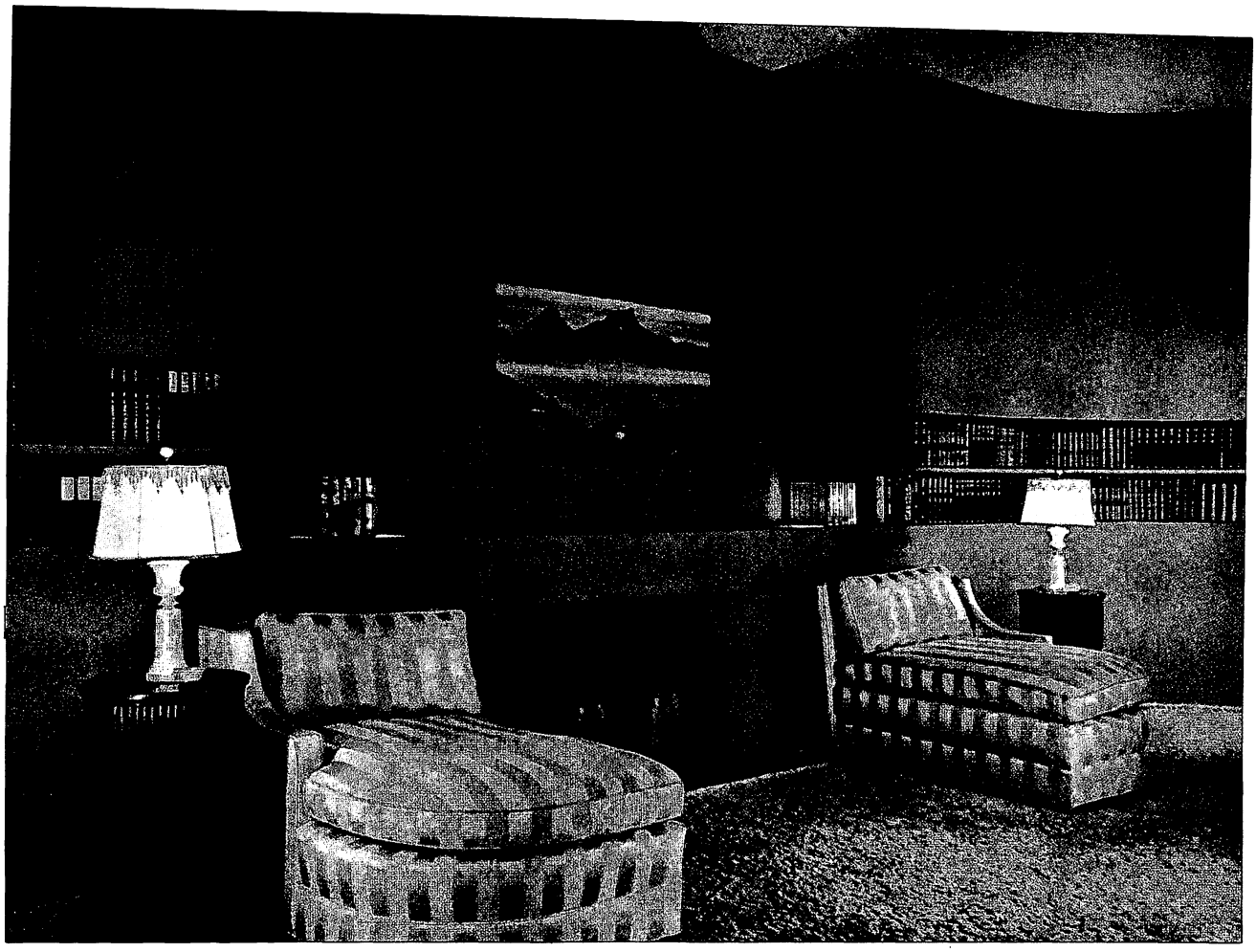
This method will give the best possible result when the density ranges of the negatives are not identical, for it matches the light tones leaving the margin of error to take care of itself in the lower, or deeper tones of your print where it will be less discernible.

Negatives for any of the printing processes should not have a greater density variation than five one-hundredths. Greater variation makes for difficult printing and juggling developers; closer than this makes for better results with much less effort.

MAKING THE SET OF BLACK AND WHITE POSITIVES Now that the exposure times have been determined for each of the three negatives, there is nothing left to do but to carry through the set of three prints for these times. To avoid mistakes it is wise to have the times written down on a slip of paper beside you.

Let us assume you have in readiness the following: a tray containing plenty of fresh developing solution (always use fresh developer for every set, for this is the only way to insure identical conditions of operation for necessary standardization). Use plenty of developer because there must be no doubt that the prints are instantly, evenly, and completely covered; if they are not, there will be streaks from uneven development which will produce very unsatisfactory color results. At the far end of the tray the thermometer should read exactly 70°F., and the thermometer in the water jacket should also read 70°F. Even a half-degree of temperature will make a difference and throw out the most careful timing of exposure; also the slightest over- or underdevelopment of one of the bromides will upset the true balance of the color print by producing too much or too little of one or two of the three primary colors. Development should be timed with a second timer, and the print held up to drain off five seconds before the required time is up, at which time precisely it should be stopped in the shortstop bath or immersed in the fixing bath and pushed around rapidly to wash off developer and stop its action.

Insert the blue printer negative (it is best to adhere throughout to the same order originally employed in making the separation negatives: red, green, and blue filters, which are now blue, red, and yellow printers) in the negative carrier of the



enlarger, and register it on the lines of the drawing previously made. Check the voltage again to see that it is the same as when the test strips were made, compensate for any change, and then expose the blue printer for the predetermined time. Keep your hand on the handle of the rheostat and an eye on the voltmeter to see if any changes in voltage occur while exposing. It is better to use the red safety filter on the enlarger than the switch for making the exposure as more accurate timing is possible this way. It takes a moment or so for illumination to fade out of a glowing lamp filament. Repeat this procedure with the red and yellow printers. Always label the prints with B, R, or Y to designate their color and write the exposure time on each. Whereas a set of bromide prints for Carbro may be developed altogether, being inserted and removed from the developer a half-minute apart, this is not practical with Chromatone, as the prints curl up so in the developer they are too difficult to manage, and with Wash-Off Relief it is somewhat impractical because of the danger of scratching the images. So for the best results, and to insure each print's receiving identical treatment, it is preferable to develop them separately, making sure that the temperature of the developer throughout the set remains at exactly 70°F.

VARYING DEVELOPMENT TIMES A well balanced set of separations with no greater than five one-hundredths variation in density range will develop in the standard developers for the standard times, but when a set is not as well balanced as this, certain compensations may be made in varying the strength of the developer or the development times. Flatter prints from too contrasty negatives, or more contrasty prints from somewhat flat negatives, may be produced by changing the developers and juggling the development times. This is a way out in case of difficulty, but not the best or easiest way to get results. Formulas for the developers for all the processes will be found in the Appendix.

DODGING Prints may also be dodged during enlarging the same as is done with black and white, only you must be much more careful not to leave uneven edges that may show up badly as color fringes in the print. Except for diminishing or increasing the exposure of a single color in a given area, it is necessary to dodge all three of the prints exactly alike, and for proportionate times, for example, if it is necessary to give extra time to flesh tones in a portrait without overprinting a dark suit with subsequent loss of color and detail. And if the extra printing time has been estimated at twenty-five per cent—then it will be necessary to calculate exactly twenty-five per cent of each one of the printing times for the three negatives to produce the required finished result.

By and large, it will be found that the production of a set of black and white positives for any of the printing processes will take at least an hour.

BASIC IMPORTANCE OF A GOOD SET OF BLACK AND WHITE POSITIVES Although most books on color photography stress the importance of the careful making of the black and white positives, it is not until

one has made quite a few prints that one comes to realize fully just how extremely important is a really good, well made set. What you put in your black and white positives—and just exactly that, no more, no less—is what you will get in your color print. Good printing is quite an art in itself, and it takes considerable experience to get into a print everything contained in a good negative—in other words, to get out of the negative all that is in it.

In case any trouble arises in the various steps of processing for color prints, substitution of distilled or even filtered water will often clear it up. By the process of elimination it will be possible to check as to where or in just what operation the trouble occurs.

It is imperative to keep a notebook on your bromides and a graph book on your separation negatives if you hope to exercise any real degree of control over the processes or achieve a dependable working standard. With this recorded knowledge and with completely standardized conditions, you should be able, even a year later, to make an exact duplicate of a given print.

For all these color printing processes a gray scale must be photographed in the composition, and here in a nutshell is the secret of all good color printing: the steps in the tone scale must match in each of the three negatives, and each of the three positives; if they do, you will get a perfect result.

With all of these processes you should check your materials before using. This is especially true of the Carbro pigmented paper and the Wash-Off dye. Make a large tone scale print and after developing, fixing, washing, and drying, cut it into three parts and process it as you would a print. If the color materials are balanced, the result should be a neutral grey. If it is not, you will be able to readily see where the trouble lies and make corrections and allowances for it, such as an addition or subtraction of perhaps two per cent to or from one of the colors which may be slightly out of balance as a result of the conditions of manufacturing. In order to avoid extra work later, it is important that you do this first.

Up to this point, the procedure necessary to all three printing processes has been similar, and a good foundation for one is equally applicable to the others, but from now on the techniques of each of the processes vary materially, and therefore each one must be described separately.

These processes fall into three categories: those that produce a toned image; those that produce a pigment image; those that produce a dye image. Dyes are said to be somewhat fugitive, pigments are apt to be permanent. The old masters of painting used earth pigments which they ground themselves. As an example of their expert craftsmanship and technical knowledge, the Botticellis in the National Gallery in London stand out resplendent with colors glowing like jewels after four hundred and fifty years.

THE CHROMATONE PROCESS

Probably, in some respects, the easiest and quickest of the three printing processes is Chromatone. One disadvantage of the process is that a fresh set of black and white positives will have to be made for every color print required. Even in Carbro, two pretty good prints may be made from one set of bromides. If much dodging or trick printing has been necessary with the positives, extra prints are more laborious, but this single disadvantage is offset by a number of advantages.

Chromatone prints may be made in about two to two and one-half hours, and the process is relatively unaffected by atmospheric and temperature conditions. It does not need hot water, and the procedure is similar to that with which the average black and white photographer is familiar—namely: developing, bleaching, and toning. It would seem that the most important point to be observed is extreme cleanliness, as the toners are very sensitive to contamination; therefore it is imperative to rinse the hands thoroughly between trays to keep from carrying any of one toner into another. Furthermore, although the washing times specified are not long, very thorough washing must be done or streaky colors will result. They will also result from uneven or improper bleaching. A few of the best known color workers use the Chromatone process, and I have seen Chromatone prints that under a cellophane covering appeared indistinguishable from Carbro. In one of these, the extreme contrast between the gradations in pure white cake icing and the depth and quality of clear black coffee in a cup would have been very difficult to produce with Carbro, as the extreme dark colors would have had a tendency toward blocking up. The Chromatone image is made of metallic pigment and permanency is claimed for it.

KIND OF NEGATIVES REQUIRED Negatives for the Chromatone process should have a density range of from .65 to .85; .75 is probably best of all if using normal paper. However, if negatives of a greater contrast than this must be used, a softer paper is available. Good Chromatone prints may be made from negatives from which a good Carbro would be practically impossible.

KIND OF POSITIVES REQUIRED The Chromatone process, like all others, requires prints with matched tone scales, but to the times found necessary for producing these is added an arbitrary extra ten per cent to the blue and twenty-five per cent to the yellow to compensate for the individual action of the toners.

Because nothing is visible on the collodion film after the prints have been developed, fixed, and bleached, it is very necessary before printing to inscribe identification marks, such as B, R, and Y (for blue, red, and yellow) with India ink on the emulsion side of the paper in order to be able to keep track of which film must be toned to what color later.

As the beginning of this chapter has taken the black and white positives past development, let us proceed from there on: The enlargements on Chromatone paper, having been developed in Formula 55-D (formula in Appendix) for one and one-

half to two minutes at 70°F., they are placed in the tray of acid fixing bath, face down. A fair amount of light may be used for developing and fixing, such as a Series O Safelight with a 25 watt bulb. However, remember, fogging tests are always the answer to how much light may be used. The prints are really very tough; and to counteract their curling, they may not only be weighted down in the fixing bath with a couple of 16 ounce graduates or bottles filled with water, but may also—after they have been fixed a while—be removed from the fixing bath and rolled up in a tube against the curl, just as one would do in attempting to straighten out a piece of curled, light cardboard. The prints should be fixed for at least five minutes, with frequent agitation. It is better to keep the fixing bath on the cool side. After the prints have been in the fixing bath for three or four minutes, the room light may be turned on.

WASHING After fixing is complete, the print to be toned yellow is transferred to a tray of running water, and the red and blue are transferred to another tray of running water. Now we come to one of the special little tricks of this process that it is well to know about. It is best to tone the yellow first and get it out of the way, which will lessen the danger of contamination in handling the other toners. While the prints are lying in the running water, mix up the Yellow Toner A Working Solution. As this solution does not keep well when mixed, and will have to be thrown out after use, mix only a sufficient quantity to properly cover the print; greater economy may be effected if particularly desired by brushing this solution over the print surface with a soft, wide, rubber-set brush. As little as 2 ounces each of Yellow Toner A No. 1 and No. 2 may be used for an 11 x 14 inch print if the brushing technique is employed. In mixing this Yellow Toner A Working Solution, which is really a bleach, always add the No. 2 part to the No. 1 part, stir vigorously, and continue to do so until the precipitate has disappeared, when the Standard Ferricyanide Solution may be added.

Now, to return to the prints that have been in running water for some few minutes: Do not, by any manner of means, consider that they have been washed, for washing is now about to commence. One of the most important requisites of this whole process is very thorough washing; otherwise streaky colors are bound to result.

Here is the best and quickest way to wash the prints: Take the yellow, which we are going to process first, and carefully strip the collodion film off the backing paper, which is thrown away. If any difficulty is found in stripping, warm the water to 70°F. or place the print in a 2 per cent acetic acid bath. Now, holding the thin collodion film down against the bottom of the tray—which is held up at a forty-five degree angle—hose off the film thoroughly, letting the water drain out of the bottom of the tray. This hosing should be done for at least two and one-half minutes on both sides of the film. It is just as important to wash off all the soluble gelatin from the back of the film as it is to wash the emulsion side, as this soluble

gelatin will pick up toner even more than the emulsion coating and cause streaks in the prints. You can feel the surface with your finger, and if it is the least bit slippery you will know that there is still gelatin present. Rubbing the finger tips over the back of the film while hosing will help to insure the complete removal of the gelatin.

TONING THE YELLOW Pour the previously mixed Yellow Toner A Working Solution onto the surface of the film, which is lying in the bottom of the tray. Pouring on the solution instead of immersing the print in it is another one of the important points of technique for avoiding streaky colors. Holding the film down to the bottom of the tray with the thumbs in diagonally opposite corners, rock the tray constantly in both directions and bleach the yellow for ten minutes. At the end of this time, holding the film down to the bottom of the tray, pour the solution out of the tray back into the graduate, and add 6 cc. of Standard Hypo Solution (formula given in Appendix) to each ounce of Yellow Toner. Hose off the film on both sides in the bottom of the tray, in the manner previously described, for one minute; then pour the Yellow Toner A mixture, containing the Standard Hypo Solution, back onto the print and rock the tray for another three minutes. Throw away this solution and hose off the film for another minute; then pour on a diluted Hypo Solution, which is the Standard Hypo Solution diluted one to three parts of water, and rock the tray. Do not keep the film longer than one minute in this solution, or highlight detail may be lost. At this time, the film will appear completely colorless and blank. Pour off this solution and give the film a thorough washing as originally described—two and one-half to three minutes on each side with a hose. Now you may pour on the Yellow Toner B (mixed one part to fifteen parts of water), when the image will immediately start to return in yellow color. After rocking the tray for a minute or two, let the film lie in this for about five minutes. Then, after another thorough washing, it is ready for squeegeeing down on paper. It may be allowed to stand to one side in a tray of water while the blue and red are being toned.

TONING THE RED AND BLUE IMAGE Although the prints to be toned red and blue may have been washing all this time, they are, again, not to be considered as washed; each must be stripped apart and carefully hosed off, separately, in a tray in a manner similar to that employed with the yellow. Now you will need your Red and Blue Toner A Working Solution; when mixing this it is advisable to use water of about 90°F., as the toners will go into solution much more quickly at this higher temperature. One ounce of water is added to each ounce of toner. This mixture, which will first contain a robin's egg blue precipitate, must be stirred until clear, when 6 cc. of Standard Ferricyanide Solution is added to each ounce of the combined A and B Toners (that is, the amount which was measured out before the water was added). Now pour the water out of the tray containing the film to be toned red, and again, to avoid streaking, pour on the Red and Blue

Toner A Working Solution and rock the tray for three minutes, after which the blue film also may be placed in the tray, taking care that it is covered evenly and thoroughly; rock and bleach both for ten minutes and then throw this bath away.

Now we come to another thorough washing, and if lime is present in the water —that is, if the water is hard—it is said it will cause loss of detail in the highlights, especially in the blue, so only distilled water should be used for washing the blue print from now on. You will note that I remarked *it is said* lime will cause loss of detail, for in actual practice the water I use in my laboratory is full of lime and I have not had to use distilled water at all. Rocking the tray with five or six complete changes of distilled water will take the place of hosing and will wash the blue properly. If no distilled water is required, each one may be hosed off separately in the bottom of a tray just as was done before. Again, be sure to wash equally on both sides. Now pour into one tray, onto the film you have marked with the letter R, the necessary amount of Red Toner B, and the necessary amount of Blue Toner B onto the film marked B in the other tray, and rock both these trays for ten minutes. In this operation the greatest caution must be exercised against carrying the very slightest amount of one of the toners into the tray containing the other. Rinse the fingers constantly in running water. At the end of ten minutes the Red Toner B is rebottled for future use, and an appropriate amount of the Standard Hypo Solution is poured upon the red toned film—at which time the red color will change to magenta. The red film is left in this solution for three minutes, and after another thorough washing it is ready for assembling.

Similarly, at the end of ten minutes the Blue Toner B is rebottled for future use, and the film is covered with a weak hydrochloric acid solution (one part to three parts water) and left in this for a minute. The blue film is now thoroughly hosed off and unless the washing is thorough after this hydrochloric acid bath, the whole blue print will stain black. Then it is placed in Standard Hypo Solution, when the greenish-blue color will change to a blue-blue color. As a test of whether the red and blue films have been left in the Hypo Solution long enough, they may be held up in front of a ground-glass covered safelight for inspection. If they are opaque in any spots, they will need to be left in the Hypo Solution longer; but if the densest portions are transparent, they may safely be assumed to have been left in long enough. Danger of contamination is ever present between the red and blue images until both have had their final hypo bath. The blue film will now require a thorough washing, after which all three films are ready for assembling.

CHECKING THE COLOR BALANCE Take a piece of gelatin-coated backing paper that has been soaking for about ten minutes, to insure full expansion, and squeegee it down tightly onto a piece of Masonite board. Then run a little water over this paper and squeegee the yellow down first. Then, by the light of a mercury vapor tube or of a bulb covered with some theatrical gelatin of a color that is minus red, register the red over the yellow. The reason for this special-colored light-

ing is that it is difficult to register red on yellow in ordinary incandescent light. Next, in room light, the blue may be registered over these two and the whole checked for color balance. If there is a predominance of any one color, it may be reduced without apparent loss of quality in the final print. Any and all of the colors may be reduced to the extent of twenty-five per cent, or even more. Reduction may be accomplished locally with a brush or set of different size brushes. It should, of course, be done before the print is assembled. (See formulas given in Appendix). It is better to do this in easy stages, as it were, for if one of the colors is reduced too much, there is no way of bringing it back. This is especially true of the blue, where the reduction cannot be observed during its progress as with the red and yellow, which can be watched against the white bottom of a tray.

An important point to be observed when checking color balance is that the amount of red should appear very slightly under what would be required for perfect balance, because when the red dries it will come up a bit stronger. Deducting about 5 per cent from the printing time of the red should take care of this condition. For checking color balance, the images may be assembled quickly in rough register in ordinary room light; but for actually registering the print, the use of the colored light will be found necessary for the red and yellow. The images are merely squeegeed down on top of one another in register; then the edges of the whole assembly are taped down to the Masonite board with ordinary commercial gummed paper tape and allowed to dry. The print may be assembled, registered, and dried taped to a sheet of plate glass instead of the Masonite board, but drying will take quite a bit longer—at least twelve hours, the drying time obviously depends upon weather conditions.

FINISHED PRINT SURFACES If the positive are printed in the ordinary manner—that is, with the emulsion of the negative toward the paper—the Chromatone print will have a very high gloss finish due to the collodion films being underneath where they cannot be removed. If it is desired that the final print have a matt surface, it will be necessary to print with the glass side of the negative toward the paper so that the collodion, instead of the image, side of the film will be uppermost in the final print. This collodion then may be dissolved with acetone and removed with a squeegee. If it is thought desirable, this procedure may be employed with each one of the three films as they are put down; but of course each will have to be dried first, which will take considerable extra time. A matt lacquer may be obtained from the company which manufactures the materials for Chromatone. When it is sprayed on the print surface it produces a matt effect. A four per cent solution of gum arabic sprayed on the surface will help to condition the surface for retouching. Collodion must be removed from the last layer for retouching. Eastman Japanese water color dyes are very suitable for this purpose.

POINTS TO BE REMEMBERED As was said in the beginning, very thorough washing between operations and the exercising of the greatest care

against the contamination of one toner by another are the secrets of success in this process. The Working A Solutions, or bleaches, are all thrown away after use, but the B Toners may be kept and used repeatedly if not contaminated, which means that the films have been so well washed as not to have any chemicals left in them which can be picked up by the B Toners. The advantages afforded by the Chromatone process are the lack of the necessity for hot water, the fact that the paper comes in two grades of contrast, and that all the colors may be reduced. Furthermore, the collodion film is very tough and whereas it cannot be treated too roughly, it does not have to be handled gingerly.

I would certainly recommend to anyone contemplating using the process that first of all he obtain the Chromatone instruction booklet from the Defender Photo Supply Company, Inc., of Rochester, N. Y., or from a photographic supply dealer. This booklet is quite complete. Trial sets, containing the materials necessary for making Chromatone prints, are available in different sizes at all-inclusive prices. (See section on Chromatone, Appendix).

THE CARBRO PROCESS

In the opinion of the majority of color workers, Carbro is by far the finest of all the color print processes. It is not so new, but until present day advertising created a sufficient demand for color prints, really intelligent efforts were not made to bring it out of the laboratory and into some sort of general practical use. However, it is a somewhat difficult process for the inexperienced.

The chief causes for failure in the Carbro process up to recent times were lack of standardization of all operations and lack of densitometric control of negatives, lack of voltage control on the enlarger, and unbalanced color tissues having insufficient adhesive element to insure their remaining on the celluloids during development. Fortunately, due to the systematic work of the Devin Colorgraph Company and other Carbro workers, and also that of Mr. Carleton Dunn with the Autotype Company, on this subject, the process has been made easier, though not radically changed. With the proper equipment and knowledge, a Carbro print is becoming increasingly simple to make. Undoubtedly Carbro yields the most beautiful prints of all the available printing processes. However, Wash-Off Relief and adaptations of it are becoming constantly more popular commercially, as it takes so much less time to make a Wash-Off than a Carbro, and duplicate prints are much more easily produced.

One of the chief differences between the appearance of a Wash-Off and a Carbro print is that the Carbro is matt in the highlights and somewhat glossy in the deep shadows, which gives the print an added feeling of depth and brilliance and a greater actual contrast range, whereas the surface of a Wash-Off is the same all over.

Carbro is a process that necessitates precise timing of all operations, and temper-

ature and humidity control. It is subject to quite a few variables, depending upon the chemical content of the water available, climate, weather, storage, and age of materials, and many other things. If you are willing to spend the amount of money required and apply plenty of concentrated, intelligent effort, you can learn to make good Carbro prints and even arrive at fairly consistent results, but don't think it will be easy.

When you see a man juggling three or four balls it looks relatively easy, and it is—after you have learned how to do it. But when you attempt this yourself for the first time you realize how awkward you are and how difficult it seems. By persevering, if you have any knack for this sort of thing, you can learn to do it—and it is just about the same with making a Carbro print. It takes some practice to become professional, or to make Carbros with reliable commercial consistency, and you probably will not get much of a print out of your first efforts unless you are one of those very rare persons who can assimilate and carry out with extreme accuracy instructions read out of a book. Every art has its technique. If you have ever tried to play the piano, you will remember how difficult it was to play your first piece, especially with any degree of speed.

THE COLD ROOM Carbro printing should be done at a temperature of 60°F. or less and in a relative humidity of about 50 per cent. If thoroughly experienced in technique, you may operate at a temperature of 70°F., and the humidity may be a lot greater and you will still be able to get along and make good prints —however, 60°F. is ideal. Commercial studios doing Carbro printing have installed air conditioning. This is for the purpose of insuring standardized temperature and atmospheric humidity throughout the year, so necessary in certain parts of the process. You don't have to have mechanical refrigeration—I have never had it. In summer, satisfactory working conditions may be provided by setting the solution trays in larger trays filled with ice and cold water, and either waiting for the cool of night or cooling the workroom with cakes of ice. For this reason it pays to work in a rather small room. Two 300 pound cakes of ice cut up to cover as much surface as possible over the work bench, with a large fan blowing on them, will bring down the temperature of a small enclosed room in one hour to 60°F. when the thermometer registers 80° or 90°F. outdoors.

CELLULOIDS Before beginning the Carbro process celluloids must be bought and prepared. Celluloid is procurable from the Celluloid Corporation of America in Newark, N. J. It should be of the nitrate, or inflammable, variety for Carbro printing. If you do not wish to go to the trouble of cutting it up and punching holes, etc., you can buy it all ready to use for Carbro work from the Devin Colorgraph Company, but it will cost quite a bit more.

KIND AND SIZE OF CELLULOID The right thickness to use is from forty to fifty one-thousandths of an inch, depending upon your choice for handling. The fifty one-thousandths is of course more rigid. Celluloid comes in sheets twenty

inches wide by fifty inches long. The company will cut it up for you for a one dollar cutting charge, but you can do so yourself just about as well. The celluloids used in Carbro work should be at least two inches larger all around than the temporary support onto which the images from them are transferred. The temporary support should be at least an inch to an inch and a half larger all around than the picture image on the celluloid. Therefore, if you are making 12½ x 16 inch prints, the temporary should be about 15 x 18 inches, and the celluloid should be at least 16 x 20 inches.

CUTTING AND PREPARING CELLULOIDS The way to cut the celluloid is to hold a metal ruler down to the surface and draw a sharp pointed knife along the edge with a good amount of pressure. You will not cut it through, but you can then pick it up. By bending it, it will break apart with a loud snap on the line where you have cut it. Having done this, take a punch and make holes one-quarter to one-half inch from the edge in the center of each of the four sides, and in the four corners. These holes are for the purpose of hanging up the celluloids or holding them in a bent position, by means of soft wire, for stretching one or both of the images into register in one method of registration. They are also good for pinning the celluloids onto a drawing board with push pins when drying the temporary support on them.

Scratch a line or lines across the upper right and lower left hand corners of the sheet in order to be able always to identify the waxed side. I believe in smoothing all the edges with No. 00 sandpaper, and slightly rounding the corners, which makes the celluloids pleasanter to handle and diminshes greatly the chance of their scratching from coming in contact with one another and with other things.

For the first try you can get along with three celluloids, one for the red, one for the blue, and one for the yellow; but you will find in general practice at least a dozen of them will be needed, for they are quite a bit of trouble to clean off and wax, and it is more convenient to do this job all at one time and have a few on hand for use. If you are doing much work, you will probably want many more than this.

PREPARING NEW CELLULOIDS FOR WORK There are two theories about preparing new celluloids for use in Carbro printing. One is that they should be washed first in slightly abrasive soap—or Gold Dust, for example. But never use anything gritty that will actually scratch them. The other theory is that merely by waxing them once, polishing them off, and letting the wax dry thoroughly and then re-waxing them and repolishing, they are satisfactory for use. When they get too scratched or worn they should be discarded. They will give a cleaner image when they are at their newest, but they will work a little more satisfactorily when they have been broken in a bit. Never attempt to clean them off in very hot water, as too much heat will make them buckle; if they become badly buckled, they will not lie flat when you attempt to squeegee your color tissue on them or when you wish to superimpose all three in register to examine the color balance of your print.

THE WAXING SOLUTION Get a cake of Autotype, brown, waxing compound from George Murphy, Inc., New York, and cut off fine shavings with a razor blade. By weighing on your photographic scales you can get the proper amounts. The formula on the package calls for half an ounce of wax to half a pint of rectified spirits of turpentine. Ordinary turpentine won't do. Double rectified turpentine is even better to use for all operations in the Carbro process where turpentine is necessary.

The best way to dissolve the wax in the turpentine is to place the turpentine in a small glass graduate which is placed in water just under the boiling point; then put the wax in it, stirring constantly until it is entirely dissolved. This solution should be filtered through flannelette into the bottle in which it will be kept. You can puncture the cork of this bottle with a nail, which can be kept in the hole when the bottle is not in use and which, when removed, will permit shaking out the waxing solution a few drops at a time. The waxing solution should be refiltered from time to time to remove any sediment. Never use the last quarter of the solution; throw it out and prepare a fresh supply.

WAXING THE CELLULOIDS The correct waxing of celluloids is very important. Too much wax will cause the image to frill off them when it is developed in the hot water bath, and too little wax will prevent the temporary support from leaving them freely when it dries. However, it is practically impossible to leave too little wax on them.

Sprinkle a few drops of the waxing solution near the four corners and in the center of each celluloid. Take a buffer that you have previously made as follows: make a block of wood about two inches square by one inch high; fasten to the bottom of this, with hot glue, a piece of springy felt (like piano felt) about a quarter of an inch thick. Make another one of these, but larger—about two by four inches. You now have the necessary tools for waxing and cleaning off celluloids and also for cleaning off the residue of wax left on your temporary support paper.

Wrap a pad of soft, white, cotton flannelette around the smaller block and spread the wax you have shaken out in the four corners and center of your celluloid, using a circular motion, until it has been distributed all over the surface. You must work fast before the turpentine dries. Take the larger block of wood covered with a double thickness pad of the flannelette and polish the celluloid up and down and crosswise. You will not be able to over-polish it, so do not worry about that. If you have ever Simonized a car, it is very much the same technique. After the first polishing, the rag should be discarded for a fresh one, ending with a third, absolutely clean flannelette which should slip very smoothly and easily over the waxed surface. If you feel an area that catches in the slightest degree, that the buffer does not slip over, that area needs more thorough polishing. Such sticky places are a sign of too much wax. As a final test, run the back of your fingernail

lightly across the surface, and if it leaves a distinct mark you haven't polished the celluloids thoroughly enough.

The celluloids should be stored in a dustproof box, as any dust or dirt on their surface when the color tissue is squeegeed down on them will show up in the print, and also make trouble in registration. It is even a good policy to run a hose over the celluloids and squeegee the water off their surface before putting down the color tissue on them. This will insure freedom from dust and also insure their being well chilled for use.

CLEANING CELLULOIDS A strong solution of Clorox in water (2 quart bottles to a gallon of water) is the only thing that I have found will remove the stain made by the pigmented paper on the celluloids. Pure alcohol will turn them white and acetone will melt them.

CELLULOID BLANKETS Six more celluloids will be required for squeegeeing the bromide into contact with the pigmented paper by running it through the wringer. If a V-type arrangement is used with either a hand or electrically operated wringer, the same thickness of celluloid previously mentioned may be used; if a horizontal arrangement is adopted, the celluloids will have to be thinner —thirty or forty one-thousandths of an inch thick being suitable for this purpose. Celluloids for the wringer, which has twenty-inch rollers, should be about 19 x 24 inches. To facilitate putting them through horizontally, they are cemented together at one end with acetone, in pairs, to form three so-called "blankets" for the blue, red, and yellow colors. They may also be fastened together with medical tape.

THE WRINGER Although the bromide may be squeegeed into contact with the pigmented color paper by hand, and such is often done in the two-bath bleach method of operation, with the single bath it has been found simpler and better to make use of a mechanical squeegee in the form of a wringer. An ordinary clothes wringer will not do. The kind to get is the No. 320 Anchor Brand Penn Easy Photo Wringer. The wringer insures freedom from slipping and tighter and more positive contact between the bromide print and pigmented Carbro paper onto which the image from the bromide print will be transferred by a tanning process, rendering parts of the pigmented gelatin insoluble in accordance with the image on the bromide. The space between the rollers should be kept in perfect alignment.

Before preparing to put through a Carbro print, the wringer should be checked by running one of the blankets through several times to see that it is functioning smoothly and properly. The way to set up the wringer with the celluloid blankets for operation is shown in Fig. 11, p. 182, in the Appendix.

BROMIDE PRINT PAPER The basis of Carbro printing is the bromide prints. Illingworth Normal Contrast Bromide Paper, imported from England by the Medo Photo Supply Company, New York, and sold by dealers in Carbro ma-

terials and Devin Bromide Paper manufactured by the Defender Photo Supply Co. are the best for this purpose. They are the papers used by most of the best Carbro workers, and come in rolls ten yards long by forty inches wide, and also in ten-foot rolls of the same width. Packages of a dozen cut sheets may be had in 11 x 14 or 8 x 10 inch sizes. If one is doing much work, the larger rolls are more economical, for they go soon enough; furthermore it is better to buy bromide paper for Carbro in roll form. Defender Velour Black may also be used with the two-bath bleach, but deeper printing will be necessary to produce the same result.

Due to the different degree of expansion of paper lengthwise vs. sidewise in a roll, it is imperative that all the sheets for enlarging be cut off the roll in the same direction or there will not be a chance of your prints' registering afterwards. For this reason, especially, most color workers buy their paper in rolls so they can be sure it is all cut off in the same direction.

DEVELOPERS FOR BROMIDE PRINTS Eastman Kodak's D-72, which to save trouble can be bought ready-mixed in cans or made up according to formula (formula in Appendix) is quite satisfactory for developing Illingworth bromide prints. For Devin paper bromide prints, Defender 55-D will be required (formula in Appendix). Greater control of contrast may be exercised by making use of a variable contrast developer (see Carbro process formulas in the Appendix). In the case of very soft negatives, a plain hydroquinone developer gives the greatest possible contrast. For extremely contrasty negatives, plain metol, which is the softest developer there is, may be used to get a good set of bromide prints, but development time must be prolonged. However, all in all, it is better to so make your negatives that the bromide prints can be developed properly in two minutes in the standard developer diluted to normal strength. This is the way to get the best results with the least trouble.

FIXING AND WASHING The bromides should be fixed for fifteen minutes, but no longer, in a fresh hypo solution (formula in Appendix) and washed for from one hour to an hour and a half. As the fixing bath ages, the prints may be left in for a longer time without harm, but in the long run it is always better to use it fresh. Hypo must be entirely eliminated or troubles will ensue, so it is best to test for complete elimination with a permanganate solution (formula in Appendix).

ELIMINATION OF FIXING FOR SAVING TIME Bromides for Carbro prints need not be fixed and will then require only half an hour's washing before use. They will have to be kept in red safelight and thrown away after use. This procedure will eliminate from an hour to an hour and a half from the total time required for the process, but the advantage of having the bromide prints on file for reference or for making duplicate prints will be lost.

REDEVELOPING AND SAVING BROMIDES A certain amount of

critical faculty, which comes only with experience and knowledge, is essential in examining and comparing for balance a set or sets of bromides. For this reason, I think in Carbro it is well to redevelop and save the bromides in order to use them later for purposes of comparison by way of printing depth and for checking the tonal value of certain colors in new sets against similar or nearly similar colors in past pictures. A good reference library of this sort, together with your notebook, is of great value under certain conditions. Nearly exact duplicates of color prints may be made from a set of redeveloped bromides. I have found this the best way to come closest to the original print. For this purpose, the bromides should be redeveloped for five minutes, preferably in plain metol developer. After this second development, about a half-hour of washing is sufficient. If any trouble is experienced washing should be more thorough.

TREATMENT TO AVOID LOSS OF HIGHLIGHT DETAIL If there is lime in the water, it will cause loss of detail in the highlights and make it impossible to get delicate and very clean white tones, such as the rose in the picture, "Chinese Girl," and the wall and table top in the "Kitchen Table." In order to correct this condition, the bromides should be rinsed in acetic acid or distilled water. After they have been thoroughly washed and hypo tested, they should be placed in a tray containing either distilled water or from one to two per cent acetic acid solution. This will depend upon local water conditions—especially the amount of lime present. They should be carefully swabbed off rather hard with a large wad of cotton, giving special attention to the highlights. Leave them in this bath for two minutes and then hang them up to dry without washing. To accelerate drying, they may be squeegeed off on a sheet of plate glass before being hung up. Acetic acid is a volatile acid, and most of it will have left the prints when they are dry. It has a tendency toward flattening the contrast and brilliance of Carbro prints, so no more should be used than is absolutely necessary to counteract the lime in the water. However, compensation can be made for acetic acid by the use of a more contrasty bleach bath.

THE SENSITIZING BLEACH BATH I know certain good color workers still make use of the two-bath bleach-sensitizer, which permits of controlling individually the contrast of each of the three color images, and it is said, also permits of obtaining cleaner and more brilliant highlights (formula in Appendix). However, I found out long ago that it is a rather hectic way to work, and I prefer and have used for a long time, the single bath method. The Devin Colorgraph Company, in its recently issued, excellent, little *Manual on Tricolor Pigment Printing,* publish the formula for such a single bath bleach exactly suited to their paper. Whereas it is slightly different from my own—which is suited to my own conditions of working—it is excellent and may be used with complete confidence with any make of color pigmented paper (formula in Appendix). The three solutions, A, B, and C, should be carefully prepared with the best quality chemicals. As has been

mentioned, it is better—although not imperative—to use none but C. P. (chemically pure) grade chemicals in all color work, but U. S. P. will be found quite satisfactory. Eastman and Mallinckrodt make reliable chemicals, and once having settled on a brand, stick to it. The A solution may be filtered with coarse filter paper after mixing, but this is not necessary if the water is pure and clear.

PREPARING FOR RUNNING THROUGH A CARBRO PRINT Put the dry bromides to soak in a tray of cold water for ten minutes, to fully expand. Trim off a sheet from each of the three rolls of color pigment paper. These sheets should be at least an inch larger all around than the size of the bromide prints. Cutting them on the trimmer makes a neater job; finger marks are to be avoided. Check the wringer. Set the clocks: one interval timer to three minutes, another to ten minutes, and the second-timer with the minute hand at 12:00 and the second hand at three minutes of, which will provide three seconds' grace in which to get under way so that the first pigmented paper will go into the bleach bath at exactly 12:00 or zero hour. Measure out the A, B, and C solutions into graduates. Fill a tray with cold water for soaking the color paper, and another with the right amount of water for the bleach bath into which the A solution may be poured. The B and C should not be added until just before use, as the bleach deteriorates very rapidly.

SOAKING PIGMENT PAPER Switch on the three-minute timer and immerse the sheet of blue pigment paper in the tray of cold water, unrolling from the center in two directions and holding open under the water. Do not let it curl up, as uneven swelling of the gelatin will occur, with uneven color results. Avoid air bubbles on the surface; they may be removed carefully with the finger tips or with a large wad of wet cotton.

After one minute has elapsed, immerse the red pigment paper in the same tray, above the blue, following the same procedure. At the end of the next or second minute put in the yellow. When the clock rings, at the end of the third minute, reset it and lift out the blue tissue and hang to drain with clips in the two upper corners. At the end of another minute, take out the red tissue and hang to drain. At the end of the next—the third minute—lift out the yellow to drain. It will be seen that it is necessary that each color tissue, or pigment paper, soak and drain for exactly the same length of time, and each must receive identical handling.

SENSITIZING AND BLEACHING PIGMENT PAPER When the clock rings again, at the end of the third minute (a total of six minutes has elapsed), pour the B and C solutions into the sensitizing bath and rock the tray well to thoroughly mix. Start the second-timer and immerse the blue pigment paper in the sensitizing solution at exactly 12:00, zero, rocking constantly in both directions. When the second hand comes up to 12:00 again, at the end of sixty seconds, immerse the red pigment paper, and in another sixty seconds, the yellow. Thirty seconds after the yellow is put in, remove the blue tissue from the bottom of the tray

and bring it to the top. The tray should be carefully rocked throughout this entire procedure to insure even sensitizing and bleaching.

SQUEEGEEING THROUGH THE WRINGER Now you will have to step lively. Fifteen seconds before the three minutes have elapsed, lift the blue printer bromide from the soaking tray and hold it up to drain until it reaches the dripping stage; then place it on the marks of the top or right celluloid in the wringer. Immediately remove the blue pigment paper from the sensitizing bath and without draining place it on the marks of the bottom or left celluloid. Release the top celluloid from its hook and holding it with the left hand, keep the bromide and color tissue apart until they enter the wringer; with the right hand, operate the wringer as quickly as possible, and then set the "sandwich" which has come through to one side. Set a ten-minute clock on it. In the tight contact between bromide and Carbro color paper produced by the wringer, the image on the bromide is transferred to or hardened in the Carbro pigmented gelatin, and whatever has not been hardened will wash away in the hot water bath, leaving an exact reproduction of the black and white bromide print image in colored gelatin.

Immediately, with no loss in time, prepare the second blanket. All this, from the time the blue tissue is removed from the sensitizing bath, should not take longer than one minute, and regular occasional rocking of the tray must be done. When the minute hand reads four minutes after 12:00, the red comes out of the bleach, is placed on the blanket, and run through the wringer in the same way as the blue; at the end of the next or fifth minute, the yellow. In the ensuing eight minutes, catch your breath, wash out the sensitizing tray and graduates and put them away. Then prepare either a tray of cold water or an alcohol bath. Put the celluloids to chill in the tray originally used for soaking the pigment paper.

If it is not possible to perform these operations alone within these time limits, either use an assistant or rearrange all the timing, as it is important that each color soak, drain, sensitize, and lie in the sandwich for exactly the same length of time. If each color is taken through separately, freshly mixed bleach bath must be used for each. Always adhere to the same order of sensitizing when putting three colors through a single bath bleach. Blue, red, then yellow, is current; and if this order is reversed, quite a different color balance may result.

SEPARATING SANDWICH AND THE ALCOHOL BATH Prepare a fresh tray of cold water—the colder the better, certainly below 60°F.—and place this next to the slab of thick plate glass on the work bench. When the ten-minute bell rings, remove the combined blue bromide and pigment paper sandwich from the celluloid blanket and place it in this tray of cold water. Then carefully peel the bromide apart from the pigmented paper under water and set the bromide to wash immediately, face down. Where air bubbles persist, it is possible to eliminate them by means of a 25 per cent alcohol bath of low temperature used in place of cold water. This alcohol bath relieves surface tension and should be mixed and

cooled before using, as mixing generates heat. In warm weather, this tray should be well iced and the celluloids well chilled to prevent slipping of the pigmented paper when squeegeeing. The pigmented paper should not remain in this bath for more than thirty seconds after the bromide has been removed. It is quite suitable for use with the Devin pigmented paper, but does not work so well with all color papers; always consult the current instructions of the manufacturer of the color paper used. Be careful at this point not to allow too strong a light to fall on the color tissue if it has been in alcohol, as it may cause a slight veiling over of the highlights. Remove one of the celluloids from the water tray, place it face down on the glass, and remove the water from the back with a squeegee. Lift it up, dry the glass in the same manner (enough water will be left on the under part of the celluloid to make it stick), then replace it in the center of the glass, face up. Be sure the waxed surface is face up. The identifying lines on the celluloid in the upper right and lower left will take care of this.

SQUEEGEEING Now remove the tissue from the water or alcohol bath, and without draining, let the lower end of it come in contact with the left side of the celluloid, which is firmly anchored on the sheet of glass. Press this end down firmly, hinging down the rest in a manner calculated to exclude air. All squeegeeing operations in the Carbro processes involve the complete exclusion of air from between the two surfaces in contact. The film of water squeezed out should always carry all air with it. Hold the left side of the color tissue down firmly with the left hand, preventing any possibility of movement, and with either a flat rubber squeegee or one of the window-cleaning variety, which I use, draw the squeegee across the pigment paper from about one-third of the distance from the left end of the celluloid, from left to right, slowly and evenly, to exclude all moisture and air. The moisture should carry the air out ahead of it. Take two more strokes in the same manner, increasing the pressure on the squeegee, and then take three strokes in the same manner from right to left. The paper should now be firmly attached to the celluloid. Pick up the celluloid, and turning it around, take strokes from left to right toward all edges of the paper, getting it as dry as possible. It is important that the exact number of strokes in each direction be repeated with all three colors; therefore it is best to standardize the kind and number of strokes. The same pressure should be applied to the same strokes in each of the three squeegeeing operations or the paper may be stretched more in one direction than in another, making one image longer or wider and difficult to register with the others later.

Examination through the back of the celluloid should show no air bubbles. If there are any, they may be removed by means of a small rubber squeegee. The common sink scraper with a soft rubber edge does very well for this purpose. If they are not removed, the image will frill off the celluloid in these places in the hot water development later. The celluloid is then placed between two photographic blotters

and rolled with light pressure to further eliminate excess moisture. Blotters for this purpose may be used repeatedly, but should be dried between uses. The roller is special and should be of very thick soft rubber, for hard rubber over a large metal core will break the gelatin in the delicate highlights, especially later in transferring.

Follow the same procedure with the red and yellow celluloids. As soon as the yellow has been put between blotters, it is time to fill the hot water trays for development. The celluloids bearing the pigmented paper may be left between blotters for from seven to ten minutes; or if the workroom is very humid, they may be hung up to dry a bit for the same length of time. In cases of extreme humidity (as when icing the laboratory in summer), a fan may be used to promote drying. Make sure each has an identical amount of breeze for an identical time. If the pigment paper on the celluloids becomes too dry, it will cause insolubility and difficult washing off in the hot water; and if insufficiently dried, insufficient adhesion resulting in possible frilling may result. Timing and methods of operation will become established in relation to individual working conditions.

DEVELOPING CELLULOIDS Fill two trays with hot water, from 110° to 115°F., and a third with cold water. Slide the celluloid bearing the blue pigment paper into the first tray, and set a two-minute clock on it. When the bell rings, you will see the excess gelatin, which has not been hardened by chemical reaction, beginning to ooze out from beneath the edges of the paper. Place the thumbs on diagonally opposite corners of the color tissue, underwater, and gently slide the tissue sideways. Then peel back the tissue slowly from the gelatin and throw it away, keeping the celluloid completely immersed while doing so. Tap the celluloid against the side of the tray to loosen the excess pigment and rinse under water until the water becomes cloudy with the dissolved gelatin. Now rinse by running it through the hot water with a pendulum movement, lifting it out of the water with both hands, from side to side, with a motion calculated to wash off as much excess gelatin as possible. The image transferred from the bromide will now be clearly apparent in blue pigment.

Place the celluloid face up in the second tray of hot water and allow it to remain while the red tissue celluloid is slid in to soak in the first tray. Before doing this, check the temperature of the water in the first hot water tray. You will find that it has dropped; bring it back up to the original 110°F. It is not necessary to change the water in the first tray before putting in the next color, but merely to keep the temperature up by adding hot water. Lift the blue celluloid out of the water, when it will be found to be still "bleeding." Rinse by sloshing it through the water in this tray until the water that drips from one corner is absolutely clear. Place it in the tray of cold water to chill for a few moments; then hang it up to drain.

When the two-minute bell rings for the red tissue, proceed with this in the same manner; likewise with the yellow. Be very sure that each color is treated in exactly the same manner. It is of the utmost importance that the images on the celluloids

be thoroughly washed, and they should be allowed to soak in the second tray as long as it is necessary for them to soak out any excess color. These gelatin color images are very tender at this point and contact with anything will ruin your chance of a good color print.

FRILLING If any frilling should occur while developing, it will probably be due to insufficient drying of the pigmented paper on the celluloid, or water of too high a temperature. If it persists as a condition, precoating the celluloids with a bichromated albumen mixture may be employed as a last resort (formula in Appendix).

DRAINING AND DRYING After the celluloids have hung for a while and are thoroughly drained off, wipe off the backs with a lintless towel. They should now be put to dry before an electric fan, a slight amount of heat may be used, but too much heat may cause the thin layer of gelatin bearing the image to crack and peel off.

CHECKING COLOR BALANCE After the three images on the celluloids are completely dry, they may be carefully superimposed in register over white cardboard, when for the first time the picture will be seen in all its colors. The color balance may be checked and decisions made as to whether a slightly stronger or weaker printing of one of the colors is needed. The tone scale will answer all such questions, because if the printing has been correct, it should appear in perfectly neutral gray tones—in other words, just as the original you photographed. For graphic information as to the appearance and results of unbalanced color images, consult the "Color Chart" in the Appendix. If the color balance is correct, and the tone scale is a perfect neutral gray, you can continue with the processing by transferring the images onto paper. If they are not in good balance, then an extra blue, red, or yellow will have to be put through, beginning at the bromide enlargement stage. However, even with controlled conditions of operation, it is very difficult to match an extra single color into a set, and it is almost preferable to make a whole new set of bromides with the indicated necessary changes. If the picture is out of balance only slightly, there might be an addition or subtraction of from two to three per cent necessary in one of the colors. Note: In registering the images on celluloids for checking purposes, care must be taken to handle them very carefully, for they scratch very easily.

TRANSFERRING THE IMAGES The Carbro images appear in the final print assembled in the following order: yellow at the bottom on the paper base, next red, and then blue on top. The reason for this order is that the yellow is an opaque pigment while the red and blue are transparent. If the yellow were on the top, the other colors could not be seen properly through it. Therefore if the three images were transferred straight off onto final support paper, the yellow would have to be put down first; as it is somewhat difficult to see the outlines of

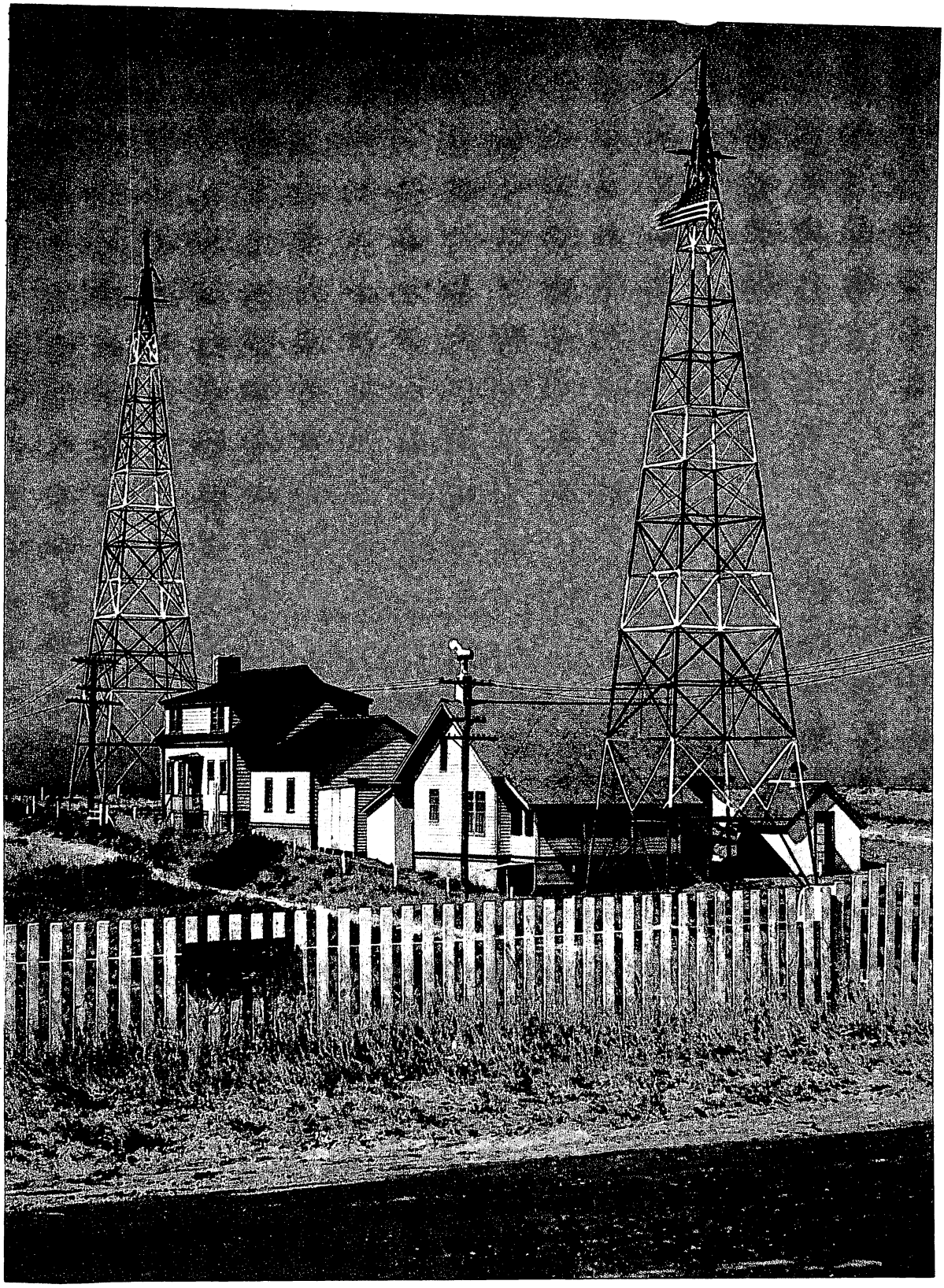
a yellow image against white, registration of another color over it would be quite difficult.

To make matters easier, a double transfer method is employed, the images being first transferred onto another sheet of paper in this order: first blue, then red, and finally yellow. This is a special temporary support paper covered with a gelatin coating soluble in water of 110°F. This temporary, as it is popularly called, is made of very stretchable paper stock to facilitate registration.

TRANSFERRING THE BLUE IMAGE As soon as the three images on the celluloids are dry, if they are in proper color balance, they are ready for transferring onto paper. A sheet of temporary support paper should be cut off the roll and trimmed squarely on the trimmer to a size allowing at least a one-inch margin on the sides and more on the top and bottom around the color image on the celluloid. The paper should be soaked, gelatin side down, in either very clear filtered, or even better, distilled water at 60°F. for ten minutes in order to allow for full expansion. Be careful that the whole is completely submerged—first face up, then face down—and that there are no air bells clinging to the gelatin surface; otherwise there will be dry patches in the paper where air has prevented the water from reaching the gelatin. This will make trouble, and if it should occur, these air bells must be eliminated in the early stages of soaking or it will be better to cut up and soak a fresh piece.

After five of the ten minutes have elapsed (use a clock with a bell for all transfers to insure standardized times), the celluloid to which the blue image is attached should be carefully slid into the water, face up, under the floating temporary support paper. This sliding motion will prevent air bubbles from forming on its surface.

At the end of the full ten minutes, the celluloid and temporary support should be withdrawn together (hold the paper to the celluloid with the thumb of the right hand, which is used for withdrawing the celluloid from the water) with an upward-sweeping movement calculated to exclude air, and laid upon the sheet of plate glass used for squeegeeing. The temporary may be moved around until the image is centered, and then it should be squeegeed down firmly and evenly upon the celluloid. Begin lightly, increasing the pressure and squeegeeing in all directions until all moisture has been excluded. Turn the celluloid over and look at the temporary through the back. Examine carefully for air bubbles. There should be none, and if a number of small ones are seen they indicate that the temporary was not properly soaked or squeegeeing not properly performed. If this has occurred, there is nothing to do but return the celluloid bearing the temporary to the water. After soaking, very gingerly and carefully peel the temporary off the celluloid under water and start all over again, using more care. There is a way of gently and slowly lowering the limp paper onto the surface of the water in such a manner that as each part goes over the water at right angles to the part being held up, vir-



tually all the air bubbles are excluded. Now place the celluloid, with the temporary attached, between clean photographic blotters and roll with the special soft rubber roller. Do not use too much pressure or you may break the very tender gelatin image, especially in the very thin highlights.

DRYING THE TEMPORARY Upon removal from the blotter, the temporary should have adhered firmly to the celluloid and be as dry as possible. The celluloid may then be fastened with push pins through the holes in the four corners to a large drawing board and set in front of an electric fan to dry the temporary support paper. All three color images should be dried one way up. The drier and warmer the atmosphere, the sooner the paper will peel off, but too much heat is to be avoided, especially if the composition contains very dark, thick areas alongside of very light, thin ones. Much heat under these conditions may cause the temporary to crack and tear. As this paper dries, due to the wax coating on the celluloid, it will detach itself from the celluloid and finally fall off, bearing the blue gelatin image upon it. Never attempt to assist or accelerate the paper's coming off the celluloid, as trouble will be sure to follow—part of the image will tear off the paper and be left on the celluloid. Let the temporary alone, and let it dry by itself and come off by itself, even to the last tiny spot, which may appear dry and by which it often remains most irritatingly attached.

REMOVING WAX FROM THE TEMPORARY The coating of wax which left the celluloid must now be removed from the temporary support paper or the next (red) image will not adhere. Tack the temporary down in the four corners with push pins on a drawing board kept for this purpose. Saturate a wad of cotton with rectified spirits of turpentine and wipe off the print. Then go over the surface with fresh cotton; then with a square of cotton flannel wrapped around the larger of the two buffers used for polishing the celluloids. Polish off as much wax as possible. Exchange this pad for a fresh one for the last polishing, after which the surface should be perfectly dry and clean. With this technique you will be certain that the entire surface of the image is clean of wax—which is important, for any places that have been missed will not transfer.

SOAKING TEMPORARY FOR SECOND TRANSFER Take the temporary support and again submerge it in the same water. After the back is wet and it has become slightly limp, lift it out of the water with both hands at the corners and lower it down into the surface of the water slowly to remove all air bells. The celluloid bearing the red image, face up, should have been previously slid under it just as was formerly done, and naturally, with the composition facing in the same direction as on the celluloid. Put a five-minute clock on it. At the expiration of this time, draw out the two together as before and by holding them up to the light, slide them into the best rough, quick register possible. The heat from the thumbs on the edges of the paper, if held in one place for a few moments, will serve to tack or anchor lightly its position.

EQUIPMENT FOR REGISTERING A good light will be needed for this work, such as a 200 watt blue bulb with a white-lined, drop reflector suspended over the glass plate squeegee board. Also a powerful magnifying glass of the solid block variety with a convex top, which is in focus when laid on the pages of a book or newspaper. You will also need a wash cloth soaking in cold water (ice water is best), and a small sink-scraper type squeegee. The reason for the cold wash cloth is to keep the heat of the fingers away from the gelatin images, because heat will make them stick together. Likewise, it is for this reason that the room in which registration is done must not be above 65°F. at the very most—unless you are unusually expert. The colder the room, the longer you can work at registration safely. Everything must be very cold—the glass plate on which you are working, and the blotters. Heat will cause the gelatin images to smear and stick, and make registration impossible.

There are two methods for registering Carbro prints. I shall describe first that one currently used, and later and more fully the method which—although less popularly used—I consider superior.

With the first method, the red celluloid bearing the blue image on the temporary, having been withdrawn from the water and given a light squeegee, is held up in front of a light with the celluloid facing you and the temporary support in back. The temporary support paper is moved around with the finger tips touching only the safe edge outside the picture area until as good registration as is possible this way has been accomplished. If the red image on the paper is short, it may be stretched by bending the celluloid into a concave curve; if it is long, by bending the celluloid into a convex curve. The amount of curvature having been ascertained to produce registration, it is held in this curve by means of a soft copper wire fastened to the holes in the middle of either end. The holes in the ends, sides and corners of the celluloids may all be used for this purpose.

After the image is in as nearly perfect register as it is possible to effect in this manner, local registration may be accomplished with a wash cloth, that has been soaked in cold water, used over the finger tips to push the temporary support paper from the back. After the first rough registration, this local registration is done by means of powerful, magnifying eye-glasses. When the images are registered, the celluloid is hung up to dry in front of a fan. The technique of registration is something that each person will have to learn for himself with practice; to the best of my knowledge this subject has always been rather briefly and casually treated in books on the Carbro process, I am trying here, I believe for the first time, to go into the matter in somewhat greater detail in order to assist the reader of this book in his first attempt.

REGISTERING THE RED AND BLUE IMAGES Lay the celluloid down on the glass plate and squeegee the temporary very lightly to remove the excess moisture and air. The celluloid is then picked up, and by transmitted light the

image on the paper is moved about, holding the temporary only by the borders until it registers as well as possible over the red image. Then give the temporary another light squeegee and turning the celluloid over upon a fresh photographic blotter, squeegee the water off the back. Squeegee the moisture off the glass plate. Lay a fresh dry blotter down on the glass plate and lay the celluloid, with the temporary underneath, next to the blotter. If any air bubbles are visible, they must be removed with a small squeegee before commencing local registration.

You are now about to begin registering your first Carbro print, and patience and delicacy of operation are what you will need most. Women usually do this work better than men—probably for the reasons just mentioned. Discouraging as it may appear at first, only perseverance and practice, and spoiling a few prints, will teach you how to master what everyone making Carbro prints must be able to do.

Beginning at the part of the print nearest you, check for registration, first by eye, and then with your magnifying glass. It is always best to start at the part nearest you and work away from you, because the heat from your hand or arm as you work on the celluloid will cause it to set; and if once the images have really set, they stick together in such a way that they cannot even be soaked apart.

Let us say that you are registering the tone scale, because this is again such a good subject on which to demonstrate. You probably will find—if not by eye, under the glass—that the ends or the sides of the scale are not in exact register. You may see only a slight red hairline projecting beyond the blue. Leave the glass in place, wring out the wash cloth, and using it to push or pull on the surface of the celluloid, start to work the lines of the image into exact register. Bear in mind that the red image on the celluloid is the one you are moving. Try with a gentle push or pull at first. The image should move, but not too easily. If it moves too easily, give the area you are working on another light squeegee and try again, repeating the process until the image moves into register with some little effort, and stays there.

After this area is registered, by the time you get down into the center of the print you may find it has dried sufficiently to obviate further squeegeeing. If it moves into register too easily, it will pull out again just as easily. It should stick tightly enough to stay in place once you have pushed it there. If, on the other hand, it takes a great deal of pushing to register, you had better resubmerge the celluloid in the water, and under the surface, gently peel the temporary off the celluloid where you are having the trouble. If the difficulty has occurred in the lower portion of the print, you need not, of course, separate the images farther than where the trouble lies; then, after lifting the celluloid out of the water with a quick upward movement you may very lightly squeegee the separated images back together again. Check this separated portion for air bubbles, and if there are any, you will have to return it to the water and repeat the process. However, if this part of the celluloid is kept well covered with water while you are performing the separating operation, there should not be air bubbles present. You will now find

that the images are again in a workable condition and registration is once more possible.

The main thing to bear in mind is to keep the parts you are not working on in a damp, workable condition so that by the time you get to them they will not be so dry that they are beyond possible manipulation.

A FEW EXTRA TIPS ON REGISTRATION Sometimes during registration, due to pulling the paper around, air pockets will start from the edge of the temporary support and will run into the picture area. One of the small, soft squeegees mentioned is very good for removing them, which must be done with a strong, quick stroke.

Another thing to bear in mind is never to push *too* hard while registering because the paper will tear. Whole areas can be moved in at once, and it is always easier and better to move the larger areas first and then work with the smaller details later.

It is especially important to work very carefully at the corners if the registration is in the direction of the edge of the paper, as there is very little resistance here and the temporary is very liable to slide back suddenly away from the corner, which will often damage both images beyond repair.

The lighter areas will always dry and set more quickly than the heavy ones; therefore the latter should be left till the last to work on. In cases of great emergency, when you are confronted with a very small area that cannot be registered in the usual manner without pulling an adjoining area out of register, the only thing to do is to register this area by transmitted light by pushing from the back or paper side in the other manner of registration. Remember when doing this that it is the blue image in the first transfer or the purple in the final transfer that you are moving. Take the cold, damp wash cloth and very lightly push the temporary support wherever you wish it to go. Do not push too hard, or you will break down and flatten the fine gelatin lines of picture detail and possibly tear the paper.

REGISTERING THE YELLOW IMAGE After registration of the blue and red images is completed, pin the celluloid up to dry in front of a fan as before. When the temporary has dried and fallen from the celluloid, you will have a purple image in, we hope, perfect register. Clean this image with turpentine as you did with the blue, and following the same routine, soak the combined blue and red on the temporary with the yellow on the celluloid for five minutes. At the end of that time, remove them and register, as you did the other two images, remembering that it is always the image on the celluloid that you are moving.

It is sometimes advisable to let the yellow soak for eight to ten minutes before registering, as this particular image will stick more tightly and quickly than the other two.

Now that registration is complete, you are on the home stretch, and the rest will be comparatively easy. But before proceeding, it should be obvious to you by now

why it is important to register the bromide images carefully when making your enlargements, and why it is necessary to squeegee the pigmented tissue onto the celluloids in as nearly an identical manner with all three as is possible.

PREPARING THE FINAL SUPPORT While the yellow is drying, cut off and square up on the trimmer a sheet of final support paper. Defender Matt A Backing Paper is in popular current use. The final support paper manufactured by the Autotype Company of England should be soaked for half an hour in 70°F. water to insure full expansion. It will be necessary to soak Defender backing paper for only ten minutes, but in 120°F. water, to swell up and enhance the sticking quality of the gelatin coating. It is important to keep the entire surface of the paper submerged while soaking. This may be done by weighting it down with a length of darkroom rubber hose.

It is a good idea, especially at first, to put some mark on the back of the paper to avoid making a mistake in this final step, for if you try to transfer onto the back instead of the gelatin coated side you will lose your print, and all your time and trouble will have gone for naught. At the end of the ten minutes, remove the final support paper and let it drain off by holding it up by one corner. Then place it in a tray of clean, cold water to chill—this time with the gelatin surface up again; the mark which you have put on the back of the paper will tell you which side is which.

TRANSFER TO THE FINAL SUPPORT After the temporary support bearing the completed transfer has come off the celluloid, it should be cleaned off with turpentine in the manner previously described, making sure that the cleaning has been thorough. Then trim off the outer edge containing the push pin or thumb tack holes, and perhaps a few small tears, to within a half-inch of the picture area. Immerse it in the large tray of cold water in which the final support paper is floating, face up. Pull the final support paper through and under the water to insure completely covering its surface, and then let it stand face up—but completely submerged—for one minute. Then remove it from the water and lower it down in the manner previously described for avoiding air bubbles. Let it rest face down in the water for another minute, at which time slide it over the final support paper which is now grasped with both hands, the thumbs holding the temporary to its surface in the two upper corners, and lift it straight up out of the water to insure quick drainage with exclusion of air from between these two surfaces. Lay the final support paper down on a sheet of glass, face up, with the temporary on top. Squeegee the two surfaces together, as previously described, in all directions and until as much moisture as possible has been squeezed out of this sandwich. The drier you can get it, and the tighter the contact, the better. By a corner, lift it up off the sheet of glass; squeegee all the water off the glass; lay a new blotter on the glass, then the final support on this, and another new blotter over it. Roll with the roller lengthwise and crosswise, and with greater pressure than previously employed. Lay on top of the whole a thick sheet of plate glass, and on top of this place bottles of pho-

tographic solutions to a total weight of about ten pounds, and set a half-hour clock on it.

DEVELOPMENT OF THE FINAL SUPPORT Just before the expiration of the half-hour, run a tray of 110°F. water, and when the bell rings, lay the combined final and temporary, with the temporary underneath, on the surface of the water. The temporary is placed underneath so that the hot water will start melting its soluble gelatin as soon as possible. With a cupped hand, spread water over the back of the final support to keep it flat. Put a two-minute clock on it. This operation is very similar to developing the pigment tissues on the celluloids.

When the bell rings, take hold of one corner of the final support, and pulling at it lightly see if the temporary loosens from it, leaving the color image on the final support. If it does, which it should, turn over the combination, and under water, starting at the corner you have loosened, peel back the temporary off the final support and throw it away. The excess of gelatin on the surface of the picture should now be washed off. This can be done either by sliding a large celluloid under it and holding the paper to the celluloid, bathing the surface of the final—as was done with washing the images on the celluloids—or with a gentle hot water hosing. Avoid too high a temperature and too much pressure, for if the water strikes the surface of the print too hard the thin gelatin image will start to blister or tear and come off. Always hose from the middle of the print out toward the edges to avoid any chance of bringing up the edge. When this has been thoroughly done, lift the print out of this tray and chill in a tray of cold water to set the gelatin image.

DRAINING AND DRYING Hang this final print from a shelf edge with a couple of push pins for a minute or two, during which time you can cut off to the required length some pieces of ordinary commercial gummed tape, and get ready a smooth board like a drawing board on which to fasten the print. Lay the print down on the board, centering it carefully, before it touches—as it should not be moved once it has been placed. Wet the tape with a wad of cotton and tape the edges of the print to the board, pressing it down with the finger tips from the center outward along its length. Be sure that this tape is rubbed down tight, even using a small towel when rubbing. If the edges of the gelatin image show any tendency toward frilling, they may be stuck down with a soft camel's hair brush dipped in alcohol, or a solution of half alcohol and half water. This treatment also applies to any other areas which may show a tendency toward coming up, probably produced by insufficiently delicate hosing technique or too hot water. The print may now be put up in front of an electric fan to dry. If it is preferred, a sheet of clear or white opal glass may be used on which to dry the print instead of a drawing board.

MOUNTING After the print is thoroughly dry, it may be cut off the board with a razor blade; the taped edge should be trimmed off and the whole nicely squared up on the trimmer. Mounting is usually done by means of a dry mounting press, but for Carbro prints the temperature should be held down a bit and a

couple of sheets of Bristol board interposed between the print surface and the hot metal plate.

Prints that are dry mounted are liable to come up at the corners, so I mount mine with a fine quality paste called Arabol. The print should be laid face down on a sheet of clean wrapping paper and the back gone over with a damp sponge. It is left to absorb moisture and is responged from time to time until it has become thoroughly limp. Be careful that the print, once having been laid in place, never moves, and that no water from the sponge is allowed to reach its surface.

When a raised corner falls back limply, it is ready for the paste, which should be applied evenly with a soft wide brush—first with a rotary motion and then with strokes lengthwise and crosswise. The layer of paste should be fine, thin, and perfectly smooth, as any lumps will show through the surface of the print later. This pasted surface is then centered over and laid on a heavy piece of mount board and a fresh piece of wrapping paper placed over it. The print is then smoothed out and rubbed down from the center outward to the edges with the hands. The wrapping paper is removed to check the results. The print is left to stand for a couple of minutes; then it is re-covered with clean wrapping paper and rolled with a roller, which this time may be of a harder variety, but still, care should be exercised.

In order to keep this surface from curling, counter mounting will be necessary, and a sheet of either wrapping paper of the same thickness as the print, or another sheet of final support paper the same size as the print should be mounted on the back to counteract curling in drying. Although wet mounting is a great deal more trouble, it is the method used for mounting the finest and most valuable drawings and etchings, and I believe it is the most permanent and best in the long run.

RETOUCHING One of the advantages of the Carbro process is that retouching is possible all along the way. You can retouch your bromides with pieces of razor blades, which are very useful for scratching out spots and scraping down small areas. You can use this same method of removing spots or influencing small areas on the three color images as they are transferred onto the temporary support paper—after it has been dried, of course.

It is more difficult to retouch Chromatone and Wash-Off Relief prints, due to their hard, somewhat glossy surface. Air brushing has a tendency to lie on top of the surface instead of sinking in, and when it comes to scratching out spots, which is often the only way to get them out—unless they are bleached out with ammonia on cotton on the end of a toothpick, as can be done with Wash-Off—you have not three layers of color gelatin to scratch through, but are scratching through the single gelatin or collodion emulsion surface or coating of your print. This leaves dull marks that catch the light quite unpleasantly when the print is seen in certain positions.

Retouching of prints is best left to a competent expert who, for one thing, knows how to handle an air brush well, which takes at least a year's practice. Spots

on the final print can be taken out if they come from lack of one or two of the colors in a small area. For example, you have a violet spot on your print, which means that the yellow is missing in that small area. By carefully filling in with the brush the required amount of missing yellow, you will arrive at the color supposed to be in that area of the print. For doing this kind of retouching you will need solutions of the three primary colors, and they should be made from the same colors from which the pigmented paper was made. These can be obtained from the manufacturers of the paper.

Retouching of any sort is tedious work and best done under a powerful magnifying glass, or with powerful magnifying eye-glasses, which are also useful for negative retouching. The less retouching on prints the better, for although I have seen some seemingly hopeless prints pulled together and made salable by retouching, the final results were far from being satisfactory to a really experienced, critical eye.

Good retouching is costly, but it is necessary. Practically every color print you see has had a certain amount of retouching done to it, even if only matching out a few little spots. It is practically impossible to imitate certain photographic textures successfully by means of retouching. As I said before, the best time to do your "retouching" is when you take your picture, by so carefully arranging and balancing your lighting that practically no retouching is necessary. Besides, it is a lot cheaper.

MATTING As a final step, a matt may be cut. It takes an expert to do this well if the board is thick and a fine bevelled edge is desired. Now there is nothing left to do to finish off the job but to sign your name in the lower right hand corner.

IN CONCLUSION As I said in the beginning of this section, the principles of the Carbro process are far from being new, and whereas the registration of the images and the necessity of a cold room for doing so are probably the weakest part of the whole process, it is a sound process that has stood the test of time and is capable of permanent and beautiful results.

I have written more fully about Carbro because it is the process that I use most, and because up to recently all the material for it came from England and there was much less dependable literature available on the up-to-date aspects of this process. However, very recently the Devin Colorgraph Company brought out a little manual that sells for thirty-five cents and is certainly worth having, and I would also recommend Mr. Carleton Dunn's book *Natural Color Processes.*

With Chromatone and Wash-Off Relief, quite complete information about processing is available; this is especially true as regards Chromatone. This is because these two processes are sponsored by big companies who, when they go into the manufacture of a product, take care of all details pertaining to it thoroughly, such as necessary complete instruction booklets.

So far as I know, there are only three sources of supply in the United States

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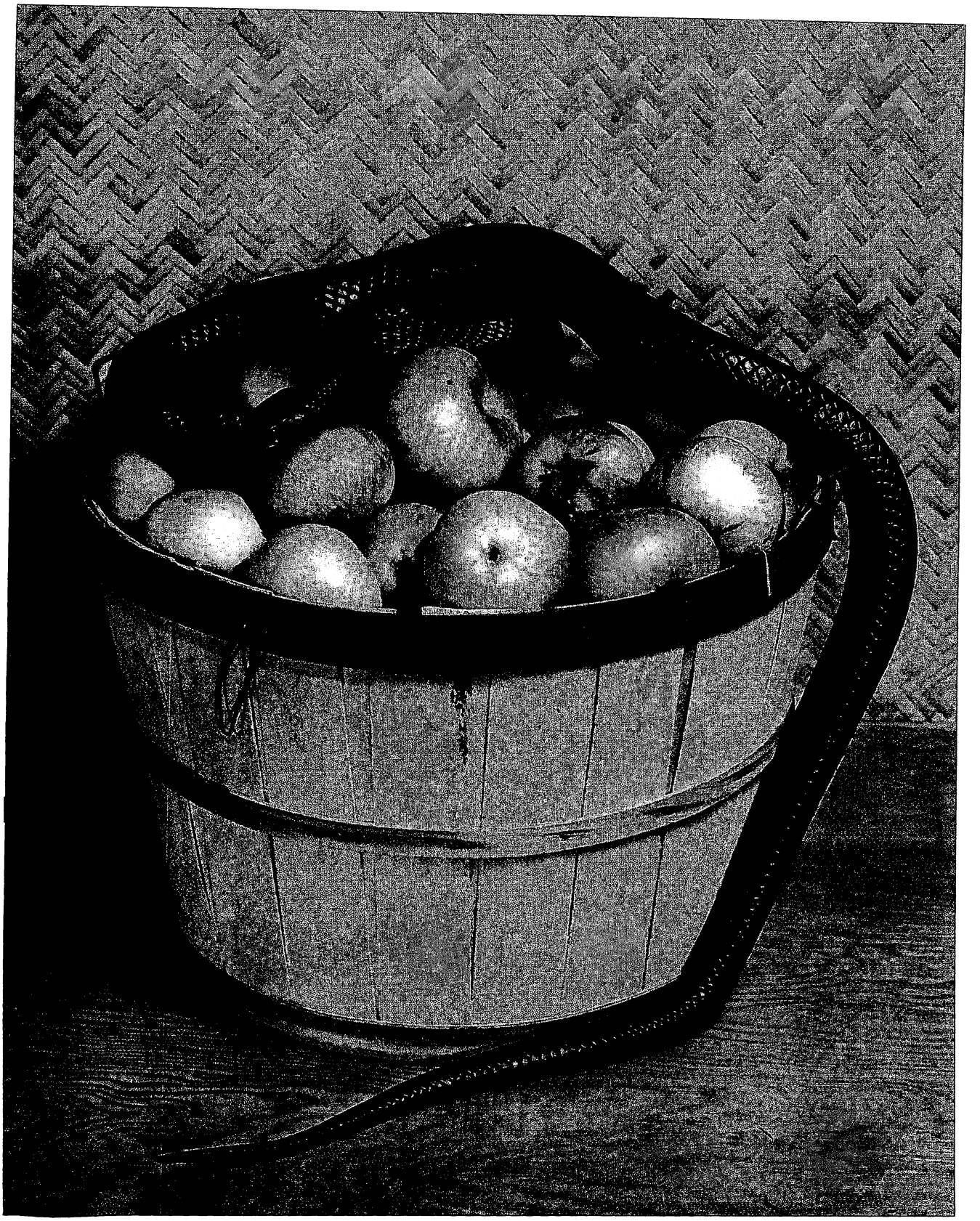


for Carbro materials, and they are all in New York City. You will find their names with further technical data in the Appendix.

THE WASH-OFF RELIEF PROCESS

The Wash-Off Relief process is far less dependent upon the temperature and humidity of the atmosphere than Carbro, and prints take much less time to make. For insuring success, if a temperature of 70°F. is maintained throughout, processing will be considerably simplified and good results much more dependable. Duplication of results and the making of a number of copy prints is possible with the Wash-Off process. However, this process, like every other, has its own little tricks, special knowledges, and also limitations. Among the special requirements might be mentioned the necessity for low density range required in the negatives; among the limitations, the lack of latitude possible in registration in contrast with Carbro, and the fact that Wash-Off Relief prints, although possessed of a tougher surface, similar to that of an ordinary semi-matt black and white print, are somewhat more difficult to retouch successfully than Carbro prints. Theoretically, prints should need no retouching, but in practice they do, and one of the greatest conveniences afforded in making prints instead of working with transparencies is that retouching is possible—and for commercial purposes is often very necessary.

OUTLINE OF PROCESS Wash-Off Relief prints are produced as follows: Black and white positives are printed from separation negatives on the special Wash-Off Relief film. This film is made of a stock very similar to that employed for aerial mapping, with the least possible tendency to stretching. The Wash-Off films are exposed through the back, usually by enlargement.

As a guide to exposure, Kodabrom No. 3, which has about the same speed and contrast as the Wash-Off film, may be used; but speed and contrast may easily vary in different emulsions, so it is wise to procure smaller size film of the same emulsion number as that to be used for the print and make your tests on this smaller film—or even better, employ the film from the box you are using. The Curtis Laboratories suggest that it is advisable for a beginner to carry a single image all the way through to completion, which—when it is dyed red, laid upon white paper and viewed through a green filter—should correspond in tone values with a normal, well-graded black and white print.

After the usual matching of tone scales, the three positives are printed and developed for five minutes. They are then washed for ten minutes in separate trays, unless processing of the film is done in film developing hangers in tanks. Then they are bleached for four minutes in a freshly mixed bleach bath, which is thrown away after use, and then developed or washed off in somewhat the same manner as the images on the celluloids in the Carbro process.

In the washing off procedure, all the excess gelatin—that which has not been tanned or hardened to form the image corresponding to the black and white

positive—is washed away, leaving this image in relief, similar to a printing plate, as it were. This relief, however, is apparently so slight as to be practically immeasurable. The film at this time appears clear except for a faint shadowy outline of the picture; and after it has been fixed for a minute, washed for five minutes, cleared, and then dried, it is ready for dyeing and the transferring of the dyed image onto a paper in register to produce the final color print.

MASKING Although masking has been suggested as a method to insure greater fidelity of color rendering, I have not found it necessary to resort to this method, and I am inclined to prefer local color retouching of the negatives or dodging of the matrices in printing as being less troublesome.

LOW CONTRAST NEGATIVES NECESSARY For the Wash-Off Relief process, it is better to have negatives of low density range, somewhere around .6 or .65, for in order to get brilliance in the prints, quite a bit of acid is necessary in the dye baths, which of course increases the contrast in the image. If you have contrasty negatives to start with, you have already cut yourself off from the chance of making use of the amount of acid necessary to obtain brilliant prints.

CONTROLLING CONTRAST With the Eastman dyes and procedure, it will be found convenient to have on hand in bottles at least three sets of dye baths, each containing a different amount of acetic acid. If, upon inspection of the three dyed matrices together in register on the back of a white tray, it is found that more contrast is needed in one or more of the colored images, all it is necessary to do is to pour into your dyeing tray another dye bath containing a greater quantity of acid, and within two minutes in this bath the image will pick up the desired added contrast.

With the system employed with the Curtis dyes, only one bath of each color is necessary. It is claimed the contrast may be increased with acid and decreased with ammonia indefinitely without spoiling the bath. Contrast may be decreased with ammonia in the Eastman dyes also, but too much of this control is not supposed to be good for the dyes.

Highlights may be reduced by merely washing them away a bit in a tray containing warm or cool tap water, and local reduction is possible by means of a gentle stream applied to the area to be reduced.

A FEW FURTHER POINTS It is imperative that the trays used for the dye baths be "medically" clean. They should not be used for any other purpose. The slightest amount of metal coming in contact with the dyes will ruin them, so hard rubber or bakelite caps should be used on the bottles in which they are stored. These bottles should be labeled with the percentage of acid contained in the dye, and the reading of the percentages changed in accord with modifications made in the baths.

It is not necessary to rock the dye trays too often, but for the sake of maintaining exact similarity of treatment of all three colors—always a prime necessity in all color work—it is better to put a bell clock on them and rock the trays twice in each direction at five minute intervals if the dyeing runs to twenty minutes, and every minute or two if dying takes only five or six minutes.

If the water used is hard—that is, if it contains a lot of lime—it will be found necessary to transfer the matrices from a one-half per cent acetic acid-distilled water bath instead of the one-tenth per cent recommended, as with the one-tenth per cent the dye may run.

BLEACHING, WASHING OFF, AND CLEARING THE RELIEFS

The tray containing the bleach baths should be constantly rocked to insure even bleaching, and washing off may be done by holding the film against the back of a nearly vertical tray and letting the gentle stream from a hose run down over its surface. Examine the safe edges of the film carefully, holding them in front of black paper, for any milky deposit, for it is imperative that all excess gelatin be entirely cleaned off. At this time, if depth of printing has been correct, you should be able to note a slight deposit on the white of your tone scale in contrast to the clear, unexposed safe edge.

For that matter, the whole image may be hosed off with hot water if the technique employed is not too rough and the water is not allowed to become too hot. The Tri-Chrome Studios of St. Paul, Minnesota, recommend using a "water mixer," a short description of which follows: The mixer consists of a large glass jar with a screw cap or a very large rubber stopper. Attached to the hot and cold water taps are short lengths of hose, the other ends of which fit over small pieces of glass tubing. These short glass tubes are fitted into two openings in the top of the jar, permitting both the hot and cold water to run in at the same time. In a third opening is set a thermometer which is so arranged that the numbered portion shows above the top of the jar and can be easily read. This thermometer will register the temperature of the water in the jar; and by regulating the amount of hot and cold water running in, the temperature of the water flowing out through an outlet hose set in a fourth opening, and with which the print is washed off, is regulated to any required temperature. However, washing off the relief films in trays is recommended as being the best method.

After the images have been washed off, they have a slightly brownish cast, which, if not removed, makes it a little more difficult to judge of the color balance when superimposing three dyed matrices in register. If the dye baths have been correctly balanced and working conditions have been standardized to an extent that permits of counting on results, the time used in clearing the images can be saved.

The relief images are very tender at this stage and any attempt to remove

little dust specks from them, even with soft, wet cotton, will damage them and show up as bad streaks, later, in the print.

DRYING THE RELIEF FILMS The relief film should be dried very slowly to insure good registration. Drops of water must be wiped off the back with a viscose sponge, as they are liable to cause drying marks on the emulsion side, and all three films should be hung right side up to prevent any chance of dissimilar shrinkage and the possibility of subsequent difficulties in registration.

BALANCING THE DYES Although much is made of the fact that control and the contrast of the individual images may be influenced considerably by the addition of different amounts of acid to the dye baths, from my own experience I have found this possibility of too much juggling of contrasts to be of much more imaginary than real value. Also, one of the points to be observed is that each of the three dyes has a different affinity for gelatin. This is especially true of the red, which will usually need some reduction by washing down a bit previous to transferring onto paper, as it transfers stronger than it appears on the matrix. With Carbro, if the color rolls are balanced, whatever was printed in the bromides prints is translated into color in exact duplication of the way it was printed in the black and white images. With Wash-Off Relief this condition does not obtain unless the dye baths have been very carefully balanced in a manner capable of producing such a result.

Therefore, for simpler, speedier, and more consistent working conditions, it is wise first of all to bring the dye baths to as near a one, one, and one printing balance as possible. The way to do this is to make a very wide tone scale, so to speak, by exposing a sheet of Wash-Off film in graded exposures. Then, after having duly processed and dried it, cut it apart into a number of small tone scale strips and dye three of them up; superimpose them in register and check to see how far the result obtained departs from a perfect gray tone scale. Then, by adding more acid in different quantities to the dyes, dyeing up more strips, combining and studying them, eventually it will be possible to ascertain the right amount of acid for each bath necessary to produce red, blue, and yellow scales, which, when combined on paper, will give the perfect neutral gray needed. It will take some little time to do this, but it will save a lot of time in the long run.

DYEING UP AND TRANSFERRING THE IMAGES With the system of processing outlined in the Eastman Kodak Company's booklet *Color Printing with Eastman Wash-Off Relief Film,* the time indicated for dyeing up the images is a half an hour with the Eastman dyes, and also a half an hour for transferring each dye to paper. But with the Curtis Dufaycolor dyes and the Tri-Chrome Studio dyes, only five to six minutes is required for each of these operations. Of course, the quicker the images can be transferred, the sharper and also more brilliant they are apt to be, for there is less of the blotting or diffusion of the image attendant upon long transfer methods.

With the Eastman dyes, keeping the matrix warm will decrease the time required for transferring. The Curtis dyes are easier to mix, and it is claimed for them that they keep indefinitely, in either concentrated or diluted form. Their contrast is entirely controlled by means of two small bottles of solution—one containing a five per cent solution of glacial acetic acid in distilled water, and the other a ten per cent ammonia solution.

TRANSFERRING AND REGISTERING THE IMAGES The images may be registered either by eye or by means of holes punched in one end of the safe edge of the matrices. A one-inch safe edge at one end of the matrices should be masked off in printing, for purposes of registration. Although this applies especially to the punching method, it is equally desirable for any other method. The Tri-Chrome Studios manufacture a stainless steel registering board with punching pegs and holes that will accommodate prints of from 4 x 5 to 16 x 20 inches. It sells for $60. Smaller models sell for proportionately less, the one for 8 x 10 inch prints being only $20. With this handy piece of apparatus, and their quick-transferring dyes, duplicate prints may be made in an average time of from twelve to fifteen minutes. Transferring is usually done in this order: red, blue, and yellow.

After having soaked a sheet of mordanted transfer paper until it is fully expanded, lay it on a sheet of plate glass, or the white opal glass squeegee board previously mentioned. Lay a sheet of .005 Kodaloid over it and with the Eastman special squeegee for Wash-Off Relief, stretch the paper down into as firm contact with the glass as possible. Then remove the sheet of Kodaloid and take out the matrix bearing the red image from either the one-half per cent or one-tenth per cent acetic acid-distilled water bath, and lay it down on the transfer paper, stretching it out by squeegeeing in all directions with as much pressure as possible. The more pressure, the quicker the transfer. Laying a blotter, cloth, or rubber pad, previously soaked in warm water, over the matrix will help to accelerate transferring.

When the transfer has been accomplished, again cover the mordanted paper, now bearing the red image, with the Kodaloid, and having squeegeed the Kodaloid down on this as tightly as possible, lay the blue matrix over it and move it around until it is in exact register with the red. The layer of Kodaloid in between, of course, prevents the image from transferring while registration is being done. When the images are in as nearly perfect register as possible, holding the left end of the matrix down with the left hand firmly, and in a manner calculated to avoid any possible movement, draw the right end of the matrix back and hold it between the teeth while the Kodaloid is removed from under it. The free end of the matrix is then carefully lowered back into position and registration—we hope—and squeegeed tightly onto the paper as previously described. A method of facilitating this visual registration makes use of a system of cutting the Koda-

loid into two overlapping pieces, which permits of squeegeeing down one-half the image onto the paper before the Kodaloid has been removed from under the other half.

With the method of registration making use of punched holes in the matrices, the images are brought into register as follows: The three matrices are registered together perfectly and checked with a magnifying glass over an illuminated ground glass; when this has been accomplished, holding them together with the left hand and without letting them move in the slightest degree, a punch somewhat similar to an office punch used for punching holes in paper for loose-leaf notebooks, may be slid under the free ends and all three punched through together.

It will be seen, relative to all punching methods of registration, that if two pegs of a size to just fit in the punched holes and spaced apart similarly to the punches exist in the squeegeeing sheet of plate glass—over which the transfer paper has been put down—all that will be necessary for registering the images on paper will be to lay the punched holes in the matrices over these pegs to bring the images into register. This will save time and make for cleaner and sharper transferring.

MAKING WASH-OFF RELIEF PRINTS SIMILAR IN APPEARANCE TO CARBROS If you want your Wash-Off Relief prints to look as much like Carbros as possible, I would suggest transferring onto a surface like Defender Velour Black Semi-Matt, which of course must first have the silver salts fixed out of it in the dark and then be prepared by treatment in the Eastman Wash-Off Relief mordanting solutions. A number of sheets of paper may be prepared in advance and stored away ready for use. They should be soaked for fifteen or twenty minutes before transferring.

RETOUCHING Spots may be removed from Wash-Off Relief prints with a little cotton wound around a match or toothpick dipped in ammonia, and when it is necessary to add color, passing the dampened brush over a stick of hard carpenter's glue before picking up the color will facilitate adherence of the colors to the surface.

WHAT MAY BE EXPECTED OF WASH-OFF RELIEF As has been noted, the Wash-Off Relief Process is possessed of certain advantages over all the other printing processes, and with certain improvements being worked out at present may, in time, very easily displace Carbro entirely—especially for commercial purposes.

9

THE ILLUSTRATIONS

SPANISH DANCER

Frontispiece

This picture, somewhat in the manner of Zuloaga, shows what can be done with a borrowed set of Kodaflectors supplemented by a homemade white cardboard reflector attached to a bridge lamp in a little shack of a studio on the tip end of Cape Cod. No one-shot camera was used for this composition; merely a Graflex and a cardboard frame set of tricolor filters. Obviously the model, who is a dancer, knew how to pose beautifully, and through dancing had acquired sufficient control over her body to permit of her holding this animated pose while the three successive exposures were made. This picture ought to give all prospective color photographers an idea of what can be done without a one-shot camera. The lighting, suggestive of a Spanish cafe, was produced by placing the lights low. This arrangement is illustrative of placing the central focus slightly off center, and balance is obviously obtained through the light spot of the straw-covered wine bottle. There are some nice, rhythmic curves, especially in the folds of the skirt, and the subtlety of all the curving lines is enhanced by the opposition of the single sharp angle of the table. The rich flesh tones came largely from much sea bathing, and careful make-up by way of eye shadow, lip and cheek rouge was added. One is not often fortunate enough to have a sitter with the ability to project her personality as well as this delightful subject did. Besides being a dancer, this subject was also a designer;

she made all her costumes herself. After one of many costumes had been selected, and the color scheme planned, the tiny local drygoods store furnished enough of an inexpensive yellow cotton material to seam together and stretch over the wall.

LIGHTING—One set of Kodaflectors equipped with the original small No. 1 photoflood lamps set 2 ft. to the right of the model and 5 ft. away. To the left 3 ft. and 3 ft. away was another No. 1 photoflood in a homemade white cardboard reflector attached to a bridge lamp. LENS—8 in. Protar. APERTURE—F/16. EXPOSURE—1 second. FILTER FACTORS—Ilford Tricolor filters. Red 2, green 5, blue 3. CAMERA—3¼ x 4¼ in. Graflex with plateholder magazine back. PLATES—Ilford Soft Gradation Panchromatic Plates. The plates were developed in a Dallon tank which is very convenient for traveling purposes because developing, fixing, and washing are performed in the one tank and because, after loading the plates into a cage in the tank and clamping down the rubber-lined cover, all further operations may be performed in full room lighting. The chemical equipment consisted of two one-gallon bottles: in one was dissolved ready-mixed D-76; in the other, packaged Kodak Acid Fixing Bath. The developer was poured in through the light trap spout in the tank, and the tank turned upside down every three minutes. At the end of fourteen minutes, the developer was poured out, rinse water was run in, this followed by the fixing bath. After five or ten minutes of fixing, the lid was removed and within a half-hour, washing was completed in the same tank. Then the cage was lifted out of the tank, and the plates were, in this instance, dried out of doors in the afternoon breeze. PROCESS—Carbro print. Due to the negatives' having been developed all together in this manner there was, naturally, no opportunity to prolong development for the customary 50 per cent for the blue filter negative in order to bring it up into contrast balance with the other two. This, of course, made for difficult bromide printing. Bromide print times: blue 4, red 4 minutes and 35 seconds, yellow one minute and 40 seconds. The blue and red bromides were developed in plain Metol for 2 minutes. The yellow bromide was developed in a combination of D-72 and Hydroquinone (1 part D-72, 1 part Hydroquinone to 2 parts of water) for 2 minutes. Another way out of this difficulty would have been to intensify the yellow negative.

IMAGES DE DEAUVILLE

Plate 1 — Page 7

Type forms have been made use of here to suggest French modern art and that certain quality of chic characteristic of French watering places. The shadows suggest sunlight and are used as accents and a means of relating the forms. The subtle, sophisticated color scheme coupled with the die in the foreground, which was used for exciting pattern purposes, echoes the sophistication of French gambling casinos. A roll of metallic paper behind the frame suggests the sea, and the sailboat, merely

an illustration clipped out of a magazine, repeats the shape of the principal central form. The metallic surfaces and pink of the shell might be considered to suggest the gowns and jewels of the women, and all that is shiny, luxurious, and expensive —especially in a modern art, chromium-trimmed manner. Although there are obviously present verticals and horizontals, the main scheme of this composition is angular. The yellow is practically a primary printing color, and the neutral grays made the use of a tone scale almost unnecessary—although one was used at the bottom, outside of the picture area, of course.

LIGHTING—2000 watt movieflood lamp clear, in Johnson Ventlite; white cardboard reflector to lighten shadow side. LENS—Zeiss Apo-Tessar. APERTURE—F/32. EXPOSURE—3 seconds. FILTER FACTORS—Ilford Tricolor Filters. Red 4, green 6½, blue 4. (The color sensitivity balance of Ilford plates was changed about a year ago, involving new and different filter factors. Those in present use are about red 2, green 2¾, blue 2¼). CAMERA—8 x 10 in. Korona View with a 5 x 7 in. back. PLATES—Ilford Soft Gradation Panchromatic Plates. PROCESS—Carbro print—bromide print times: blue 34, red 31, yellow 43 seconds. Developed in normal D-72, 2 minutes.

DUTCH GIRL

Plate 2 — Page 19

The composition of this figure is subtly circular, and it is interesting to note how the position of the hands repeats the shape of the cap, and the directional lines of the sides of the cap somewhat repeat those of the breasts. Repetition of an element of design may often be advantageously made use of in pictorial composition, just the same as it is used in musical composition. The suggested atmosphere of the out-of-doors and the sea was achieved in the studio. The model is obviously of the fine, strong, deep-chested variety preferred by sculptors, and her demure, pensive mood suggests a certain abstraction that is both compelling and intriguing without the establishment of any personal contact with the beholder. The cap is a real Dutch cap from the Isle of Marken and clearly demonstrates the value of good props, for by its use, what might have been merely a study of a girl in front of a blue-green background takes on an atmosphere and picture quality that would not otherwise have been obtained. This picture also proves what can be done by way of photographing the nude without a one-shot camera, for it was made several years ago with a sliding back. Although a slight degree of movement was present in the set of separations, a print was possible due to the latitude afforded in registration in the Carbro process.

LIGHTING—2000 watt movieflood in Johnson Ventlite plus one or two No. 11 equipped with No. 4 photofloods. LENS—Zeiss Protar. CAMERA—8 x 10 in. Korona View with a 9 x 12 cm. sliding back. PLATES—Ilford Soft

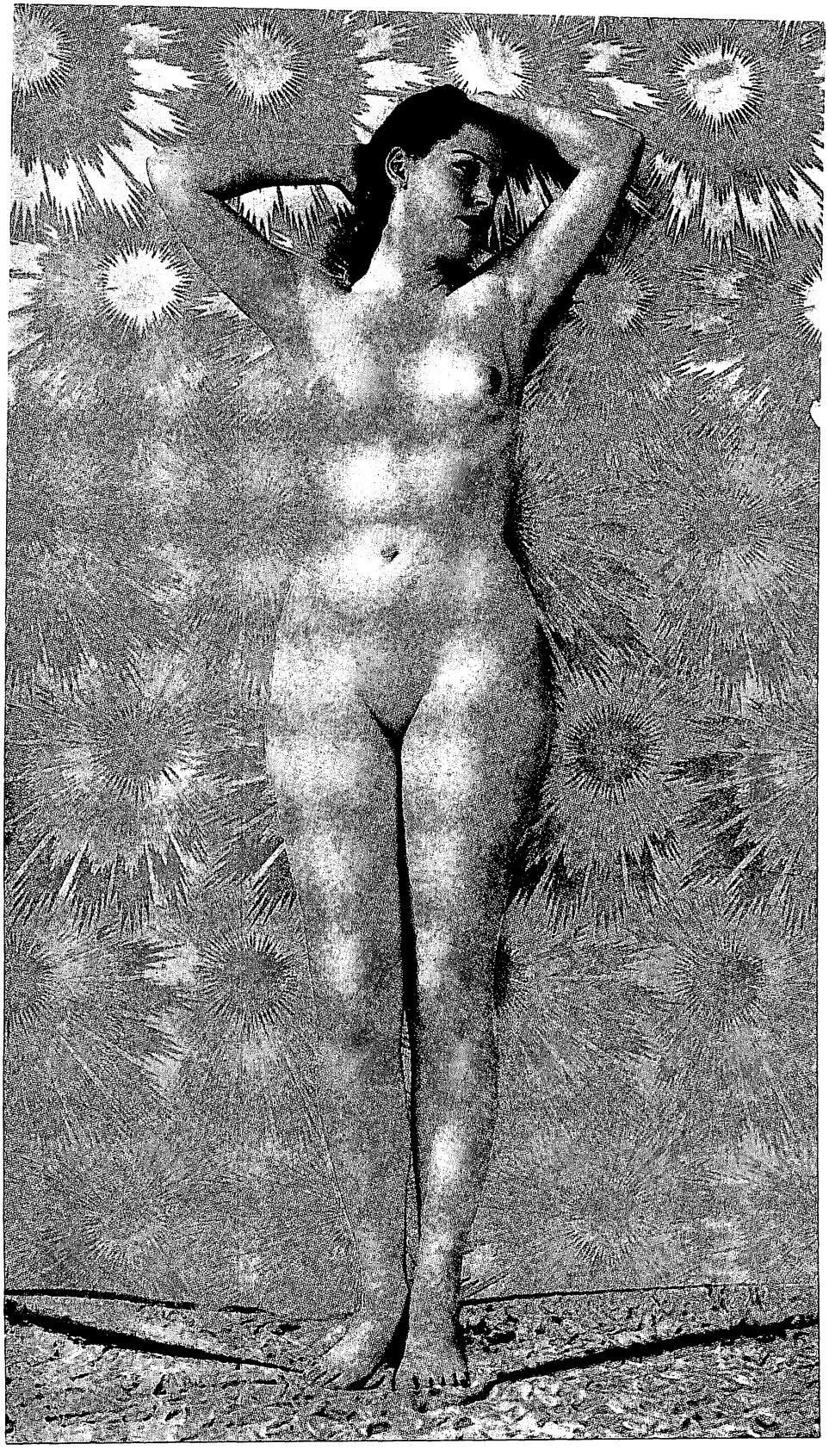
Gradation Panchromatic Plates; Development D-76, red and green filter negatives 14, blue filter negative 21 minutes. PROCESS—Carbro print—bromide print times: blue 18, red 30, yellow 30 seconds. The similarity between the red and yellow bromide times was caused by the necessity for the deduction of considerable time from the yellow due to the pigmented paper's being out of balance. Developed in normal D-72, 2 minutes.

THE POTTING SHED

Plate 3 — Page 29

This whole arrangement was designed and styled for a cover on *House Beautiful* magazine. Although its authentic realism speaks for itself, it was, nevertheless, a set built in the studio. The wood, of course, was old and had been carefully chosen from a pile that had been lying out in the weather for years. The window is a dusty relic of an old barn. The snow scene out-of-doors was painted on a white window shade, and a foot in front of it was suspended a screen of black net to get atmospheric depth. Seen through the dusty panes of glass, it presents a very real effect of looking out on a snowy, early spring countryside. The props were carefully selected and assembled from various sources. The whole picture was planned from a sketch, which is the way in which I frequently work. Besides the pencil drawing outlining the underlying abstract design—that is, the main directional lines and organization of large shapes or masses—these sketches are often developed up in color as a means of better planning. Although containing many verticals, the underlying scheme of this picture is angular as the eye is led from left to right along the shelves; thence from right to left along the counter, caught by the edge of the stool, from which it is led over to the basket, back up along the spade to the beehive, thence back to the left by means of the strong color note and directional lines of the watering can and long-handled trowel. In good composition, paralleling direction and length of lines often contributes to the arrangement as a whole.

LIGHTING—2000 watt movieflood lamp in a No. 8 in front and to the left; to the right a No. 4 photoflood in a No. 11; a couple of supplementary No. 7's lighting the lower shadow portions; two No. 11's on background seen through window; one No. 3 back of the wall, streaming in at a 45° angle onto the table top. LENS—Zeiss Apo-Tessar. APERTURE—Approximately F/45. CAMERA—8 x 10 in. Korona View with a 5 x 7 in. back attached; motion picture tripod. FILTERS—Ilford Tricolor Filters. PLATES—Ilford Soft Gradation Panchromatic Plates; Development D-76, red and green filter negatives 14, blue filter negative 21 minutes. PROCESS—Carbro print—bromide print times: blue 60, red 50, yellow 120 seconds; developed in plain Metol due to contrast in negatives.



THE PLANTER

Plate 4 — Page 41

This old gentleman in his seventies used to like to go out and cut grass in the broiling sun for exercise. Through long exposure, his skin had actually become the color reproduced. He is really not a planter at all, but a retired lawyer and writer, and one of the most learned and best-read men I have ever encountered. The arrangement is obviously very simple, the background being a white farmhouse door. I think this is a good example of the type of portraiture wherein the personality of the sitter dominates, to the exclusion of any special awareness of the medium used. Some of this quality has been lost in reduction, but I think enough remains to bear out my point.

LIGHTING—Clear movieflood lamp and Johnson Ventlite, white cardboard reflector. LENS—Zeiss Protar. APERTURE—Probably F/16. CAMERA —8 x 10 in. view with a 9 x 12 cm. sliding back. PLATES—Ilford Soft Gradation Panchromatic Plates. Development D-76, red and green filter negatives 14, blue filter negative 21 minutes. PROCESS—Carbro print.

AVOCADO PEARS

Plate 5 — Page 51

For a long time I was intrigued with a desire to do a composition making use of avocado pears on account of their fine simplicity of form, which, although basically ovoid, is even more subtle because of the irregularity of the curves. Quite a bit of the power contained in the original print is lost in reproduction, as in the original the pears are over life-size, which accentuates their pure design value by removing them somewhat from accepted naturalness. This composition is again angular and an example of the balancing of a large, somewhat centralized mass of less intense color by a smaller area of more intense color closer to the edge of the picture, where spots exert a more powerful attraction for the eye than those which are more nearly centrally placed. About a dozen of these pears were obtained from which to select the right ones for their form, shape, and for design purposes; they appear on the top of a paint box with the back of an old canvas as a background. It will be seen that these avocados form the base of a triangle, which culminates in a point on the highlight of the lemon. The color of the lemon has been purposely altered to bring it into better and more harmonious color relationship with the composition as a whole. The arrangement of all the subject matter clearly illustrates the principle of bringing light against dark and dark against light. (See Fig. 21, p. 184, Appendix, for analysis of the composition of this picture.)

LIGHTING—2000 watt movieflood in Johnson Ventlite with 1000 watt

No. 4 photoflood in No. 11 to balance up shadow side. LENS—12 in. Zeiss Protar. APERTURE—Probably F/32 or F/45. CAMERA—8 x 10 in. Korona View with 5 x 7 in. back. FILTERS—Ilford gelatin filters. PLATES—Ilford Soft Gradation Panchromatic Plates. Development, usual developing times. PROCESS—Carbro print—bromides developed in normal D-72, 2 minutes: blue 75, red 45, yellow 110 seconds.

THE RED BARN

Plate 6 — Page 63

This composition is obviously an arrangement in verticals and horizontals and will be noted to be of rather formal arrangement. The scheme makes use of two verticals connected by a single central mass. The barn stands about three miles away from my house in the country and I found it a suitable, convenient subject for the purpose of trying out the new sheet Kodachrome. Here is an example of the choice of a viewpoint capable of providing balanced pictorial composition in the most ordinary of country settings.

LIGHTING—Slightly hazy sun—1 p.m.—January. LENS—Apo-Tessar. APERTURE—F/32. EXPOSURE—1 second. CAMERA—5 x 7 in. Home Portrait Graflex on Crown tripod. PROCESS—Kodachrome—reproduction plates made directly from the transparency.

"WHERE'S BABY?"

Plate 7 — Page 75

This picture was made to order as an example of Dufaycolor for this book. On account of the slow speed of all color materials, by far the best way to do baby pictures is with flash. Babies do not mind flash, and although they blink after the exposure I feel sure no harm results to their eyes. On account of the possibility of a flashbulb's shattering, when using them close to babies they should always be enclosed with a thick cellophane cover on the reflector. Although it is possible to arrange a baby in a composition in a more or less completely controlled manner similar to that of which a painter is capable—and I have been fortunate enough to be able to do this when the necessity presented itself—no great attempt at subtle composition was made with this particular shot, wherein the compelling animation of the subject was used as the main theme. Although a background was carefully chosen of delicate pastel colors appropriate to the subject (perhaps some thirty designs of wallpaper were looked over), and the little model was "as good as gold," this arrangement might be said to be possessed of much more cutely-illustrative atmosphere than fine art quality. This is because I purposely attempted to do the kind of picture of a baby that many people would be pleased to have of their own

child. After all, they would be much more concerned with whether their little darling had that particular cute expression that they loved to see on her face rather than with any matters of fine art. In short, I was particularly concerned with showing how the easy transparency processes might be adapted to home use.

LIGHTING—Four No. 75 flashbulbs, directed as follows: one No. 10, 5½ ft. from the subject to the left front; one similar reflector, 7½ ft. to the right front, 6½ ft. high, 4½ ft. from the subject; one No. 11, 3 ft. to the right, 5½ ft. high; one No. 11 overhead, 2½ ft. above the baby's head. LENS—14 in. Goerz Artar. APERTURE—F/45. EXPOSURE—Open-shut. CAMERA—8 x 10 in. Korona View with a 5 x 7 in. back. FILM—Dufay 5 x 7 in. cut film in film sheath in plateholder. PROCESS—Dufaycolor—reproduction plates made directly from the Dufay transparency.

KITCHEN TABLE

Plate 8 — Page 87

This composition is a good example of spotting colors around against a light background. The single mass produced by the salad bowl, two peppers, and shadow is balanced by the intensity of dark cutting against white of the single green pepper. The balance created between the red pepper and the paprika tin is an excellent example of how a much smaller spot near the edge of a composition will balance a much larger spot near the center—the old steelyard balance again. The various whites of oilcloth, enamel paint, dish towel material, and porcelain are a good example of relative values and good clean Carbro printing; they also clearly demonstrate the light-reflecting value of different surfaces. Obviously this composition is angular, although in a somewhat subtle manner, and the colors are complementary. A special twist or element is introduced into the composition scheme of this picture by the use of the horizontal of the spoon paralleling the bottom edge. The forms are simple, and illustrate the design possibilities inherent in very simple, homely, everyday objects.

LIGHTING—Movieflood lamp and Johnson Ventlite, supplemented with one No. 11 containing a No. 4 photoflood. The various white surfaces around reflected white into the shadows. LENS—14 in. Single Element Protar. APERTURE—F/32 or F/45. CAMERA—8 x 10 in. Korona View with 5 x 7 in. back. FILTERS—Ilford Tricolor Filters. PLATES—Ilford Soft Gradation Panchromatic Plates. Development D-76; red and green filter negatives 14, blue filter negative 21 minutes. PROCESS—Carbro print—bromide print times: blue 22, red 17, yellow 54 seconds. Developed in normal D-72, 2 minutes. (See the "Color Chart" in the Appendix for illustration of the blue, red, and yellow bromides used to make this picture.)

CHINESE GIRL

Plate 9 — Page 99

The circular design of this composition is more apparent than in "The Dutch Girl," as the curves flow with great freedom of movement and sweep. Attention is especially called to the headdress, not as hair but as an interesting pattern shape —the one dark note or accent that snaps up the whole color arrangement. The rose was a beautiful large variety of rambler that I brought in from my own garden, and the manner in which the whites of the eyes cross-balance it in composition and how the black mass of the hair silhouettes against the background is interesting. Obviously, the whole color scheme is very Chinese in feeling; the sideways expression of the eyes lends a bit of a dramatic touch and suggests the presence of another person, and the free flowing quality of the linear arrangement suggests action without the actual existence of any. Various stories could be read into this picture. (See Fig. 22, p. 184, Appendix, for analysis of the composition of this picture.)

LIGHTING—5½ ft. from the subject and 18 in. to the right of the camera was one No. 11, 4 ft. 8 in. high, containg a No. 75 flashbulb; 21 in. to the left of the front of the camera was another No. 11, 4 ft. 6 in. high, containing another No. 75 flashbulb and this stood 4½ ft. from the subject. LENS—Apo-Tessar. EXPOSURE—Open-shut. APERTURE—Between F/11 and F/16. CAMERA —Devin 5 x 7 in. One-Shot, filters in daylight position. PLATES—Devin Tricolor Plates; Development DK-76. PROCESS—Printed by the Carbro Process. Acid lessened in No. 2 solution of single-bleach bath, to give more contrast.

THE LIBRARY

Plate 10 — Page 113

This interior was designed by Virginia Connor and was photographed for *House Beautiful* magazine in the Decorators' Picture Gallery in New York, where various of the foremost decorators hold a yearly exhibit. It is especially desirable in photographing interiors to suggest as much third dimension as it is possible to obtain—a feeling of being able to walk into the room, as it were. I think this particular interior is a good example of this. The motion pictures often make use of a close-up of an object, slightly out of focus, to enhance the feeling of atmospheric depth of perspective in a scene, and probably the couch in the foreground operates to a certain extent in this manner. The grayed amethyst color of this room is rather a difficult one to get in color photography, and although the room was flooded with light when it was photographed, the lighting was so balanced as to produce in the final print the planned effect of low and subdued lighting grading up into shadow—in other words, to reproduce the original lighting designed for the room. The reason for the flooding is this: it takes a certain amount of light to

light up colors sufficiently to photograph them as they are. As of necessity, with most pictures of interiors, the underlying composition scheme is angular.

LIGHTING—One No. 1 vertical to the left of the fireplace; one No. 1 vertical just outside the right hand side of the picture, shooting at the wall; lying on the floor in the center, directed up at the fireplace wall, another two element strip; by the camera, a No. 3 directed at the far end of the room; one movieflood lamp in a No. 8 thrown on the carpet and into the fireplace; No. 1 photofloods were substituted for the regular lamps in the built-in wall boxes with ground glass tops that are seen throwing light up onto the plants. (This was to bring the light intensity into relation with the photographic lighting of the room). EXPOSURES—Red 12½, green 25, blue 15 seconds. LENS—14 cm. Carl Zeiss Wide-Angle Protar. APERTURE—F/45. CAMERA—8 x 10 in. Korona View with a 5 x 7 in. back on a motion picture tripod. PLATES—Ilford 5 x 7 in. Soft Gradation Panchromatic Plates. FILTERS—Ilford Tricolor Filters. Plates developed in D-76, 65°F.; red and green filters 14 minutes, blue filter 22½ minutes. PROCESS —Wash-Off Relief.

GIRL WITH FAN

Plate 11 — Page 125

In contrast to the baby picture, this composition was organized carefully from various points of view. The one best angle of the head was selected with great care, and the whole arrangement keyed to the setting. An element of contrast was introduced by opposing the formality of the eighteen-nineties piece of furniture with a combination of formal pose, yet informal garb, which is calculated to intrigue curiosity. Obviously, complementary colors were used, and the linear arrangement flows freely. The gown was an old Chanel model that was let down off the shoulders, as the shoulder straps were too wide and bunchy, and in order to avoid any characteristic style element. The curve of the fan echoes the curve of the couch and the design on the fan creates a crossing curve, the ends of which culminate in both armpits. It will be noted how the color scheme has been carried out throughout, even to the jewelry. The fan was an old souvenir of Pre Catelan and Armenonville in Paris, which was dug up out of one of the prop boxes and used because its colors harmonized so well with the general scheme of the composition. Contrasts have been made use of to enhance dramatic effect: the very-much-clothed against the unclothed; formality against informality.

LIGHTING—Flash; on the right, two No. 10's with No. 75 flashlamps, 4 ft. and 4¼ ft.; one broken-mirror, metallic surface, clip-on reflector containing a No. 20 flashlamp (not shown in lighting plate) 2 ft. from red plush of couch back showing at right of model's face. (This little reflector shot its narrow beam into the light-absorbing plush to raise its exposure value into relation with the rest of the subject). Another similar reflector was used in the same way at the left 1½ ft.

from the model's head. To the right of the camera, 6 ft. distant, another No. 10 with a No. 75 bulb; to the left of the camera, 6 ft., still another No. 10; and to the left, 3 ft. from the subject, a Kodaflector throwing light into the skirt and onto the tone scale. One No. 11 equipped with a No. 75 flashbulb 28 in. over the model's head. LENS—Hugo Meyer, F/4.5, 8¼ in. Aristostigmat. APERTURE—F/16. EXPOSURE—Open-shut (1/50 of a second). CAMERA—Lerochrome 3¼ x 4¼ in. PLATES—Super Panchro Press Plates. Developed in Edwal-12—red and green 9, blue 11½ minutes. PROCESS—Carbro print—bromides developed in normal D-72, 2 minutes. They had to be dodged considerably to compensate for the great difference present in the light-reflecting value of the various surfaces and the difficulty of color separating the red of the couch. The times were as follows: blue 2 minutes, 47 seconds, flesh dodged in 30 per cent, red plush held back 20 per cent; red 4 minutes, 10 seconds, flesh printed in for 30 per cent, skirt held back 20 per cent; yellow 5 minutes; flesh dodged in 30 per cent, red plush held back 30 per cent.

THE RADIO TOWERS

Plate 12 — Page 137

The underlying vertical and horizontal arrangement of this composition will be seen to be like that of "The Red Barn," and therefore provides a good example of how a similar underlying scheme of composition may be applied to two quite dissimilar subjects. There is a secondary angular arrangement involved: the triangular construction of the towers repeating or re-echoing the roof tops. Basically, the color scheme is one of the most ancient and fundamental: red, white, and blue. Combinations of red as an advancing color against blue as a receding color are probably some of the oldest of which any records exist. The towers belong to the Highland Light Radio Station right beside Highland Light on the tip end of Cape Cod. The lighthouse, which is to the right—outside the picture area—is the most powerful on the Atlantic Coast and high up on a salt-windswept cliff. In the background may be seen sand-dunes. The length of exposure necessary on this bright August afternoon did not permit of stopping the movement in the flag, produced by the breeze. (See Fig. 20, p. 184, Appendix, for analysis of the composition of this picture.)

LIGHTING—Bright sunlight—3 p.m.—August. LENS—Apo-Tessar. APERTURE—F/16. EXPOSURE—1/10 second. CAMERA—Devin 5 x 7 in. One-Shot. PLATES—Tricolor Plates. Developed in one-gallon tank of DK-50. PROCESS—Carbro print. No further information available as records were neglected; bromide prints were not fixed and therefore had to be thrown away. This provides an excellent opportunity for calling attention to the advisability of keeping and preserving data records.

WAITING FOR EVE

Plate 13 — Page 147

This composition is so termed for lack of a conveniently available, better title and because it will probably increase some people's enjoyment of the picture to add a bit of literary suggestion—in other words, to give them a story to think about. The basket of apples and snake are both treated as a single unit in a manner similar to what would be appropriate for the treatment of a vase of flowers, for example. You will notice if you look at the work of many of the great flower painters that their arrangements were practically invariably centered in the most simple and direct manner. The underlying scheme of this composition is circular with the single angular surprise element of the snake's tail introduced, which was a product of good fortune and perhaps inspiration on the part of the snake. The apples came off the tree right outside my house in the country. There were a number of baskets like this standing around on the veranda last autumn. Looking at them from day to day and the beauty of their pastel colors suggested the possibility of relating all this light with a single dark accent. As I had the snake and had often wanted to make use of him for pictorial material, it suddenly dawned on me that my chance had come. So after rummaging around for a suitable background material and locating a Mexican straw mat, the whole composition was arranged in the studio on a piece of veneer board which was wet previous to exposing to bring it to the depth and color thought desirable. About 22,000 watts of photographic light were concentrated as much as possible, and I soon found out that although snakes like heat they don't like that much. So I had to shut off the lights and let Abba, as he is called, cool off for a little while, and then put them on and make the one-second exposure without delay. As I said in the beginning, I had no thought of a title when I made this picture. It was not made with any story-telling idea in mind, but merely from the point of view of the dramatic relationship of line, form, and color. If I had really wanted to make this a story-telling picture, if I had had to meet the demands of modern advertising, in order to have done a proper job on it I might have been obliged to picture the snake looking at his wrist-watch impatiently.

LIGHTING—One No. 2 and one No. 3 moved in as close as possible—3 to 4 ft. In front, beside the camera, a No. 5. LENS—Apo-Tessar. APERTURE —F/22. EXPOSURE—One second. Automatically timed with compound shutter. CAMERA—Devin 5 x 7 in. One-Shot. PLATES—Devin Tricolor Plates. Developed in DK-50, green 8½, red 8¾, blue 11½ minutes. PROCESS—Carbro print—bromide print times: blue 42, red 32, yellow 30 seconds. Developed in D-72 —blue 1½, red and yellow 2 minutes.

BEAUTY

Plate 14 — Page 159

This fine, thoroughly womanly figure I think will compare favorably with many good paintings of the subject and such a thing is quite difficult of achievement in photography with its many ever-present limitations. Dignity and simplicity are produced by a main vertical and horizontal underlying scheme of composition, supplemented with a subordinate angular scheme; as it will be noted, drawing lines from the elbows down to the center of the body between the legs and connecting them at the top will produce a practically perfect triangle. Attention is called to the use of the repetition motif as the folds in the floor-ground repeat the movement of the arms. To keep the pose from being too static, a slight degree of action has been introduced by the bending of one of the knees. The headdress is simple, youthful, and classic—a fitting crown for such a truly lovely example of womanhood. The whole composition is possessed of an utter simplicity and directness that is possible only with the finest of figures. Relative to what was mentioned about becoming acquainted with the possibilities of a model's figure, this picture was not made the first time this model was used; it was the excellence of her proportions that suggested it, and considerable care and thought were given to finding just the right background material—one that would be appropriate to as fundamental a subject as beauty itself. In this composition I tried to suggest somewhat of the atmosphere and delicacy of coloring of a pink pearl against a mother-of-pearl background; of Aphrodite arising from the sea, and of a universal and eternal quality. As to how well I have succeeded remains for time to prove. All I can say about it is that it comes closer to my idea of a good nude than any others that I have done up to the present.

LIGHTING—No. 1 overhead with two elements; 8 No. 2 photofloods 5 ft. from the model; a right and left hand strip containing the same standing vertically just under the right and left hand end of the No. 1 overhead in such a way as to make a frame. On the floor rather completing the frame was a single No. 1 unit (4 No. 2 photofloods). This totals 28,000 watts, drawing 140 amperes. The side directional light was produced by a No. 2 about 6 ft. distant. LENS—Carl Zeiss Apo-Tessar. APERTURE—F/16. EXPOSURE—½ second. CAMERA—Devin 5 x 7 in. One-Shot. PLATES—Devin Tricolor Plates. Developed in DK-50. PROCESS—Carbro print—single-bleach bath.

APPENDIX

APPENDIX

If you have read the text of this book carefully and decided on a process, by means of the formulas and time charts included here you should be able to go ahead and experiment. However, I would certainly advise that before attempting to proceed you secure the instruction books issued by the manufacturers. After all, books are cheap enough—about the cheapest part of your color photography investment—and they may very possibly save you quite a bit of both time and money. Among the many good books on black and white photography, I might recommend to you *The Fundamentals of Photography* and *The Photography of Colored Objects* by Dr. C. E. K. Mees, head of the research laboratories of the Eastman Kodak Company, and *Elementary Photographic Chemistry,* all published by the Eastman Kodak Company; *Making A Photograph* by Ansel Adams, published by the Studio Publications, Inc., New York; *Photography Theory and Practice* by L. P. Clerc, and also *Photography Its Principles and Practice* by C. B. Neblett. *The Dictionary of Photography* by E. J. Wall will be found a very handy reference book, and on color *The History of Three-Color Photography* by the same author, both published by the American Photographic Publishing Company in Boston. Other excellent books on color which might be mentioned are *Color Photography and Practice* by D. A. Spencer, published by Pitman in New York; *Curtis Color Handbook* by Thomas H. Curtis; *Natural Color Processes* by Carlton E. Dunn, American Photographic Publishing Company of Boston; *The Eighth Art* by Victor Keppler; *Exposure Makes the Picture and Exposure Makes the Print* by Harvey P. Rockwell of the Weston Electrical Instrument Corporation, and The International Printing Ink Company's monographs: *Color As Light, Color Chemistry* and *Color in Use.*

The processing times in this Appendix are as near to average as can be estimated; certain of them will probably take you much longer at first, except those that absolutely must be done on a definite time schedule or produce no result. After a while you may find it possible to cut down the times indicated, but I must warn you that slighting washing in a process like Chromatone, to cite just one example, is bound to lead to failure. Once again I must stress the importance of working as cleanly and as carefully as possible, and of mixing the formulas correctly. Neglect of some very small detail of procedure in processing may be found to be the reason for failure to get good results.

CAMERAS AND CAMERA EQUIPMENT

CAMERAS

Korona View

8 x 10 in.	$ 60.75
5 x 7 in.	53.25
4 x 5 in.	47.00

Eastman View

8 x 10 in.	$ 80.00
5 x 7 in.	70.00

Autotype Sliding Back

3¼ x 4¼ in.	$ 85.00
Extra Double Plate Holder	24.00

(Imported by Geo. Murphy, Inc., 57 E. 9th St., New York City)

One-Shot Single Mirror Lerochrome

5 x 7 in. without lens	$198.00
2¼ x 3¼ in. with lens	180.00

One-Shot Double Mirror Lerochrome

5 x 7 in. without lens	$750.00
3¼ x 4¼ in. with lens	365.00
3¼ x 4¼ in. Special Daylight Model	382.00

(Manufactured by National Photocolor, Inc., 480 Lexington Ave., New York City)

One-Shot Double Mirror Devin

5 x 7 in. Standard Model without lens	$985.00
5 x 7 in. Precision Model without lens	1185.00
6.5 x 9 cm. (2½ x 3½ in.) Precision Model with F/4.5 Aristostigmat	365.00

(Mfg. by Devin Colorgraph Co., 305 E. 43rd St., New York City)

Eastman Graflex Plateholders

Special springs installed and marked for color by Devin Colorgraph Co.

5 x 7 in. each	$ 4.50

Devin Precision Plateholders

5 x 7 in.	4.00
6.5 x 9 cm.	3.00

Lerochrome Plateholders

5 x 7 in. Single Mirror	$ 6.50
5 x 7 in. Double Mirror	4.50
3¼ x 4¼ in. Double Mirror	3.00

Single Mirror Pressure Plateholders

5 x 7 in., per pair	$ 8.00
Curtis Color Back	$150.00

LENSES

Carl Zeiss Apo-Tessar F/9

9½ in.	$140.00
12 in.	168.00
18 in.	252.00

Carl Zeiss Protar F/6.3

6 in.	$114.00
9¼ in.	189.00
12¼ in.	286.00

Goerz Artar F/9

6 in.	$ 69.00
9½ in.	138.00
12 in.	145.00

Hugo Meyer Aristostigmat F/4.5

6 in.	$ 54.00
9½ in.	135.00
12 in.	200.00

Schneider Xenar F/4.5

6 in.	$ 46.00
9½ in.	115.00
12 in.	159.75

Lerochrome Wollensak F/6.3

6 in.	$ 37.50
8½ in.	49.00
12 in.	62.00

LENS HOODS

Wörsching, imported by Hugo Meyer

For 5½ in. F/4.5 Aristostigmat	$ 4.50
No. 4 for 12 in. Apo-Tessar	5.00

Hollywood Sunshade & Filter Holder can be had in all sizes to accommodate both 2 in. & 3 in. filters.

Price 2 in.	$ 9.00
2½ in., $12.50; 3 in.	20.00

ENLARGERS

Phoenix Autofocus

5 x 7 in. with lens	$425.00

(Imported by Medo Photo Supply Corp., N.Y.C.)

Saltzman

8 x 10 in. with fluorescent mercury vapor tube without lens	$575.00
5 x 7 in. model	350.00

Simmon Omega

4 x 5 in. without lens	$175.00

Optikotechna

Laborant

4 x 5 in. with F/4.5 color-corrected lens	$132.50
Laborant model 5 x 7 in. same as above	289.50

(Imported by Chess-United, N.Y.C.)

Elwood

5 x 7 in. Autofocus with F/6.3 B. & L. Tessar	$190.00
Elwood Special 5 x 7 in. without lens	63.00
Elwood 8 x 10 in. commercial without lens	125.00

Argon tube for, complete, manufactured by Simplex Specialty Co., Inc., 204 E. 33rd St., N.Y.C.

MINIATURE ENLARGERS

Omega without lens	$ 48.00
Leitz Focomat	$ 75.00 to 228.00

Super Multifax

35 mm. to 6.5 x 9 cm. F/4.5 color-corrected lens	$ 89.50

EXPOSURE METERS

Weston-Model 715, Master	$ 24.00
Weston-Model 650, Universal	19.95
Weston-Model 628 Studio	99.00
General Electric	19.50

COLOR TEMPERATURE METER

Eastman		$ 27.50
Set of CC Filters	2 in.	$ 3.15
	3 in.	7.00
No. 76 & 86 Series Filters, each	2 in.	1.00
	3 in.	2.25

DENSITOMETERS

Eastman Transmission, about	$160.00
Eastman Transmission and Reflection, about	380.00
Lerochrome Transmission	17.50
Lerochrome Reflection	27.50

Both Lerochromes make use of General Electric Exposure Meter, price $19.50.

Lectrochrome Transmission, Reflection, and Color Separating	$225.00
Weston Transmission	75.00
Monochromatic Viewing Filter	$ 2.50
Magnifying Lens Tube for Ground Glass	$ 2.00

PLATES AND FILMS

PLATES FOR SEPARATION NEGATIVES

EASTMAN

Tricolor

3¼ x 4¼ per doz.	$ .83
4 x 5 per doz.	1.10
5 x 7 per doz.	1.84

Super Panchro-Press

3¼ x 4¼ per doz.	$ .90
4 x 5 per doz.	1.22
5 x 7 per doz.	1.98

WRATTEN & WAINWRIGHT

Panchromatic

3¼ x 4¼ per doz.	$ .74
4 x 5 per doz.	1.01
5 x 7 per doz.	1.66

Hypersensitive Pan

3¼ x 4¼ per doz.	$ .83
4 x 5 per doz.	1.10
5 x 7 per doz.	1.84

ILFORD

Soft Gradation Pan

3¼ x 4¼ per doz.	$ .90
4 x 5 per doz.	1.50
5 x 7 per doz.	2.45

Hypersensitive Pan

3¼ x 4¼ per doz.	$ 1.05
4 x 5 per doz.	1.70
5 x 7 per doz.	3.00

DEVIN

Tricolor
(made by the Eastman Company)

6.5 x 9 cm. per doz.	$ .80
5 x 7 per doz.	2.20

FILMS FOR SEPARATION NEGATIVES

DEFENDER

XF Pan

3¼ x 4¼ per doz.	$ .85
4 x 5 per doz.	1.10
5 x 7 per doz.	1.80

Dupac

5 x 7 per doz.	$ 3.50

Tri-Pac

5 x 7 per doz.	$ 5.10

Three-Color Combination

5 x 7 per doz.	$ 5.10

(All obtainable in various sizes)

EASTMAN

Portrait Pan

3¼ x 4¼ per doz.	$ .55
4 x 5 per doz.	.73
5 x 7 per doz.	1.17

Supersensitive Pan

3¼ x 4¼ per doz.	$ .55
4 x 5 per doz.	.73
5 x 7 per doz.	1.17

Super Panchro-Press

3¼ x 4¼ per doz.	$ .62
4 x 5 per doz.	.80
5 x 7 per doz.	1.31

AGFA

Superpan Press

3¼ x 4¼ per doz.	$ .85
4 x 5 per doz.	1.10
5 x 7 per doz.	1.80

COLOR FILMS

KODACHROME

Cut Sheets

2¼ x 3¼ per ½ doz.	$ 3.90
3¼ x 4¼ per ½ doz.	5.25
4 x 5 per ½ doz.	6.75
5 x 7 per ½ doz.	10.50
8 x 10 per ½ doz.	21.00
11 x 14 per ½ doz.	40.00

Also available in 6.5 x 9 cm. and 9 x 12 cm.

Roll Film

35 mm. for Miniature Cameras, 18 exposures, Per Roll	$ 2.50
For Eastman Bantam, 8 exposures, Per Roll	$ 1.35

Kodachrome Prices include processing.

DUFAYCOLOR

Available in all sizes, some of which are listed here.

Roll film, 6 exposures

From 1⅝ x 2½	$ .90
to 2½ x 4¼	1.75
Miniature Camera Film (35 mm.) for Leica, Argus, Marvel, Kodak Retina, 18 exposures	$ 1.40
For Contax and Super Nettel, 18 exposures	$ 1.40
For Robot, 24 exposures	$ 1.60

Film Packs (8 exposures)

From 2¼ x 3¼	$ 2.75
to 4 x 5	6.00

Cut Film (6 exposures)

From 6½ x 9 cm.	$ 2.60
to 8 x 10 in.	20.00

PHOTOGRAPHIC LAMPS

PHOTOFLOOD

No. 1 each $ .20; 6 for	$ .80
No. 2 each $ .40; 6 for	$1.60
No. 4 each $1.60; 6 for	$6.40

PHOTOFLASH

No. 21 each $ .20; 6 for	$ .80
No. 75 each $ .75; 6 for	$3.00

MOVIEFLOOD

Clear 2000 w.	$ 5.25
Frosted 2000 w.	5.55

This lamp may be operated on voltages from 105 to 120, alternating or direct current. It is constructed in the PS-52 clear bulb, 6½ in. in diameter, 13⅛ in. in over-all length. Mogul screw base. Consumes 2000 watts. Rated life: 15 hours at 115 volts.

LAMPS FOR SPOTLIGHTS AND PROJECTION FLOODS

100 or 105 volts

NOTE: 100 volt lamps are closest to average photoflood temperature.

500 w. T-20	$ 2.40
1000 w. T-20 CP Tubular	5.25
1000 w. G-40 CP Clear	5.75
1500 w. G-40 CP	8.25
2000 w. G-48 CP	13.00
5000 w. G-64 CP	23.00
10,000 w. G-64 CP	65.00

GENERAL ELECTRIC "3200°K." MAZDA LAMPS SPECIAL FOR KODACHROME

500 w. A-25 Med. Screw	$ .70
1000 w. G-40 Mog. Screw	6.75
1000 w. PS-52 Mog. Screw	4.25
1500 w. PS-52 Mog. Screw	6.00
2000 w. G-48 Mog. Bipost	11.00
5000 w. G-64 Mog. Bipost	25.00

LIGHTING EQUIPMENT

(See Fig. 1, p. 177)

This illustrates the sort of lighting equipment necessary for doing color photography professionally in the studio. As it is necessary to first flood the subject with light—a ground lighting, as it were—and then snap on accents here and there, I designed for this purpose a set of strip lights, No. 1, which may be combined in various ways. As a key to the relative size of the different units of the equipment shown in this photograph, each of the strip elements is 3 ft. long. With this information anyone should be able to find out the length, width, or height of any of the other lighting units shown by simply laying a ruler on one of the strip elements and then making the necessary comparative measurements. I had these strips made 3 ft. long so that they would all pack into the trunk of a car and be conveniently transportable. Although three overhead elements—making a total of 9 ft.—are shown hooked together on the 6½ ft. rolling stands, which also may be raised to over 9 ft., I usually make use of only two overheads for figure and portrait work though four may be combined within a 6 ft. width for stronger overhead lighting. In these elements may be used either No. 1 photofloods, which will give each 3 ft. unit a rating of about 1000 watts (9½ amperes) and provide about 2000 watts of photographic light, since these lamps are undervolted, forcing the filament to burn more intensely and doubling the actinic value of the light, although greatly shortening its life. Or the longer life No. 2 photofloods may be used, entailing a total for each unit of 2000 watts of current (19 amperes) or about 4000 watts of photographic light. You can see, therefore, that if you are using the No. 2 bulbs, as I do practically all the time, and are framing the subject with two side strips and two overheads, you are pulling some 12,000 watts (about 115 amperes) and you have an approximate illumination value of 24,000 to 25,000 candle power. Four of these 3 ft. elements may be combined to make a square frame for so-called shadowless lighting for a head.

These elements are wired in two circuits so that in every other socket may be placed a flashbulb. The subject may be lighted with photofloods which are left on up to and during the making of the flash exposure. If desired, No. 1 photofloods may be used in one circuit and No. 2 in the other. By joining four of these strips together with a diffuser in front of them on a rolling stand, we arrive at an illuminant approximating the character of light provided by an ordinary window. If it is desired to have a larger single bank source of light, even eight of these units may be joined together on a single rolling stand. These strips have countless uses and if it were not necessary to make them transportable they would be much more efficient with larger reflectors. In their simplest form they may be made merely of vertical boards painted flat white on one side, and along which side porcelain sockets can be strung together. On account of the intense heat, wood cannot be used for overhead strips. Approximate price of the whole outfit shown, complete with stands and cables, is about $250.

No. 2—a large spun aluminum reflector containing a 5000 watt 100 volt lamp. The flat grid filament and general construction, as well as the appearance, of this lamp is similar to that of the smaller 2000 watt lamps in the spotlights and the larger 10,000 watt lamps obtainable but not shown. This 5000 watt lamp is also used in the larger size housings of the same type as No. 7. Such a lighting unit as this is useful for modelling with highlight and single directional sources of light. While it is not as efficient for getting the light to the subject as the same size lamp would be behind a Fresnel lens in an enclosed housing, it produces softer and very even illumination over a large area. Approximate price of reflector and socket, $30. Bulb, $23.

No. 3—known as a Rifle Spot, containing a corrugated, polished metal reflector and a 2000 watt (19 amperes) frosted movieflood lamp gives an illumination rated equivalent to that of five ordinary 1000 watt lamps. This is a useful unit for projecting fairly even floodlighting some distance from the light source. For example, in doing a room interior in which a large wall mirror occurs in the composition, this light is suitable for illuminating the opposite wall, to one side and in back of the camera, which appears in the mirror. The Rifle Spot has a number of other uses, and among them might be cited the obtaining of the effect of sun streaming through a window in a studio set. In passing, it might be mentioned that movieflood lamps are one of the more dependable sources of light, and although they do not emit light as white as that emitted by photofloods, they have a much longer life. Approximate price of reflector with stand, $90. Bulb, $5.55.

No. 4—a heavy, counter-weighted, spring-balanced, rolling, studio stand for the greatest convenience in overhead or back spotlighting. The housing contains a 2000 watt 100 volt lamp for use on regular 115-120 volt current. (Again this undervolting is for the purpose of producing a whiter light that ties in better with the color temperature of the photoflood bulbs.) The life of the lamp, especially if burned at too acute an angle, is quite limited. Either a clear condenser lens may be used in spotlights, which permits of decreasing the area of the spot, or one of the newer Fresnel lenses, which produce a considerably greater light efficiency. Spotlight lenses should be selected of as clear white glass as possible. They sometimes yellow with age, which of course changes the effective color temperature of the light. Approximate price of housing and stand, $210; 2000 watt bulb, $13.

No. 5—What has been said of No. 4 applies also to No. 5, which gives an idea of the appearance of the bull's-eye Fresnel lens, except that since the No. 5 lamp house is longer, when a clear condensing lens is used, it is possible to draw the light down to a smaller spot. Approximate price for housing, to take 2000 watt G lamp, and stand, $70.

No. 6—is simply a smaller 500 watt spotlight similar to No. 4, mounted on a counter-weighted arm which locks

in place at various angles by means of teeth that engage with one another. Roughly speaking, it is merely a smaller, less powerful, and much less expensive device for producing the same kind of lighting as that produced by No. 4. Housing and stand, $90.

No. 7—shows a housing with Fresnel lens designed to accommodate a T-20, 500 watt projection bulb which, for color, is preferable in 100 volts. This type of unit comes in various sizes for lamps ranging from 1000 to 10,000 watts. Approximate price of unit shown, including stand, $19. For an idea of the cost of the larger sizes, the popular 5000 watt lamp unit costs around $150.

No. 8—a good old Johnson Ventlite. Still one of the best and most efficient photographic floodlights made. In it may be used anything from a 100 or 105 volt 1000 watt clear lamp to a clear or frosted 2000 watt movieflood, practically without any semblance of hot center. Of course, the frosted bulb will give an even softer light than the clear. Price, $25.

No. 9—is on the order of the old theatre box lights. This reflector is really very inefficient from the standpoint of projecting the light to the subject at any distance, but it does produce very soft and even illumination. Either No. 1 or No. 2 photofloods (shown) may be used in it, and I have had mine specially wired with two circuits so that the bottom row may be used for photofloods and the top row for flashbulbs. Equipped with ten No. 2 photofloods, it pulls about 50 amperes and gives the equivalent of 10,000 watts of photographic light. This box will give faint multiple shadows unless a thin ground glass or Traceolene diffusion screen is used. Grooves are provided in the front of the box for this purpose. Colored gelatins may also be used in this unit and from them some very unusual effects can be obtained, but a great deal of caution and knowledge must be exercised in attempting colored lighting and the tone scale must be illuminated by only white light. Approximate price, $32.

No. 10—a Victor Banquet Reflector. The aluminum parabola is calculated to give the utmost in flashlight efficiency. The socket casings unscrew, permitting of nesting any number of reflectors for transportation. In this unit is pictured a No. 75 flashbulb which is four times as powerful as the standard No. 20 pictured in No. 12. With these lights, quick change sockets are very useful, as they permit of instantly pushing bulbs in and pulling them out without the loss of time involved in screwing them in and out. (You will just about be able to make out one of these sockets in No. 11). Three or four of these No. 10 units supplemented with several No. 11's and No. 12's make a fair all-around set of flashlight equipment for small area subjects. Reflector and stand, $15.

No. 11—a very useful and efficient little portable unit. The socket part may be unscrewed so that a number of reflectors may be nested together for carrying purposes. From what I have observed, this reflector is only about half as efficient as No. 9, but the light is more even and there is less of a hot center. With Nos. 10 and 11, No. 4 photofloods, drawing about 1000 watts and providing an equivalent of 2000 watts of photographic light, may be used equally well for incandescent floodlighting. Approximate price of reflector and stand, $12.50.

No. 12—illustrates the very efficient little Kodaflector, containing a No. 20 flashbulb. Although but one reflector is shown mounted on the stand, the outfit comes equipped with two reflectors mounted side by side. No. 1 or No. 2 photofloods, or No. 10 or No. 20 flashbulbs may be used. The reflectors unhook and flatten out into practically no space. For their size and price, Kodaflectors are extraordinarily efficient small units and, on account of their somewhat narrow beam, quite good for plugging up small, dark holes in the lighting when using flash. Price, $5.

No. 13—a flatter type of parabola that will spread the light more evenly, and also a handy clamp-on method of attaching lights wherever they may be needed. Approximate price, $6.

No. 14—this is merely an open No. 2 photoflood which is useful for back-lighting a figure or a head and shoulder portrait, and for other purposes where an open bulb may be necessary.

No. 15—the plugging box shown is of the six (50-ampere) receptacle type. Approximate price, $43.

The sources of the lighting units shown are: Walters Electric, J. G. Saltzman, Kliegl Brothers, and Century Lighting, all in New York City; and the Johnson Ventlite Co., Chicago, and James H. Smith & Sons, Griffith, Indiana. Mr. Walters has made a science of catering to the problems and needs of the best-known photographers doing color work, and would probably be a good man with whom to discuss problems of lighting or a contemplated installation. To give some idea of what this sort of lighting costs, rough prices have been included—although it is to be remembered prices fluctuate. However, this list will give a fairly good general idea of the cost of studio lighting equipment.

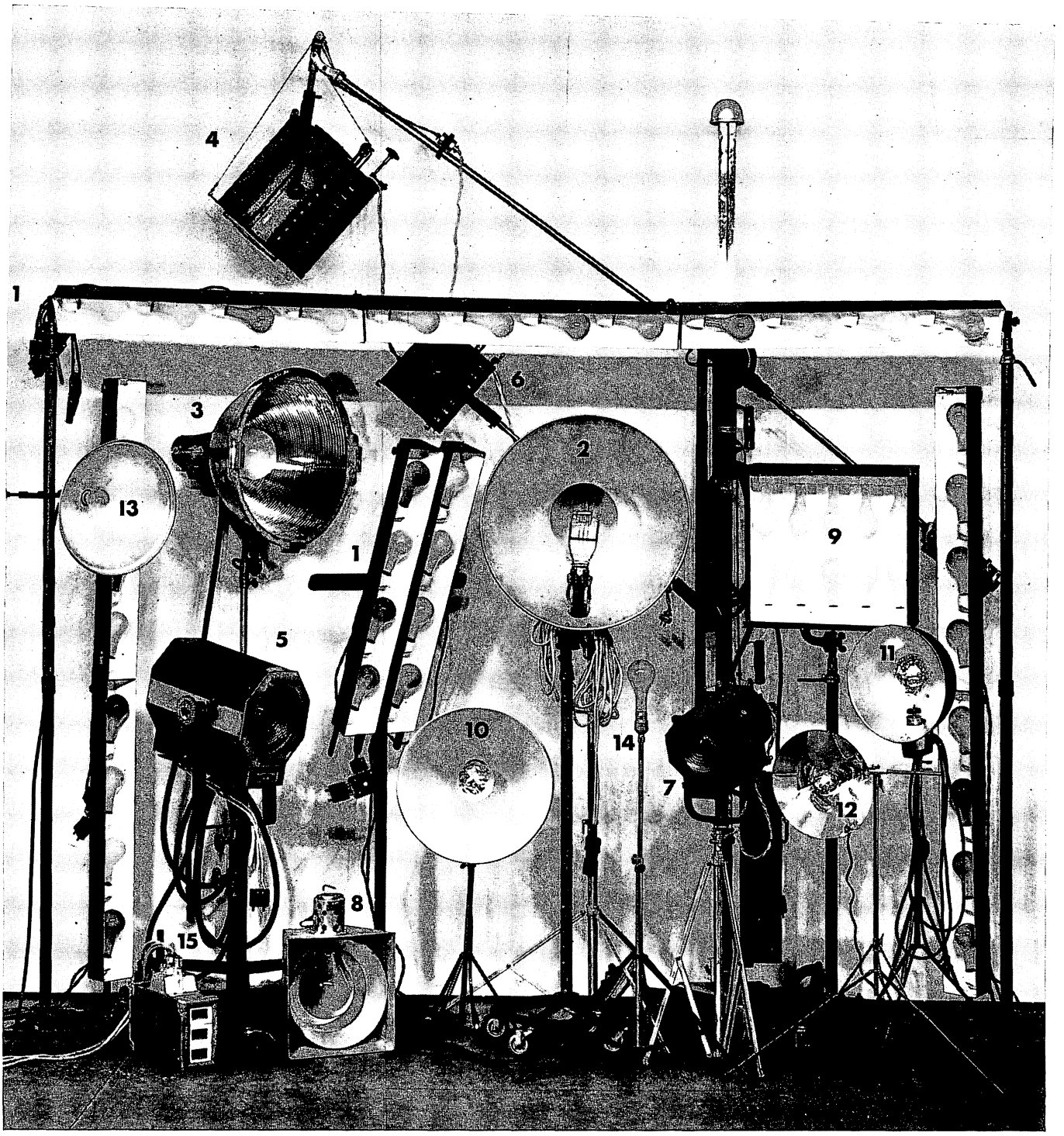


Fig. 1—(1) Strip lights containing photofloods; (2) Spun aluminum, matt-etched reflector containing a 5000 watt lamp; (3) Rifle spot with frosted movieflood lamp; (4) Saltzman, counter-weighted, rolling, 2000 watt spot; (5) Kliegl 2000 watt spot with Fresnel lens; (6) 500 watt spotlight; (7) 500 watt spotlight; (8) Johnson Ventlite containing a frosted 2000 watt movieflood; (9) Theatre box light equipped with No. 2 photofloods; (10) Victor Banquet Reflector; (11) Sunray Reflector with No. 75 flashbulb in quick-change socket; (12) Kodaflector containing a No. 20 flashbulb; (13) Flat, parabolic type reflector containing No. 1 photoflood; (14) An open bulb on stand; (15) Plugging box containing six, fifty ampere receptacles.

(See page 175-176 for descriptions and prices.)

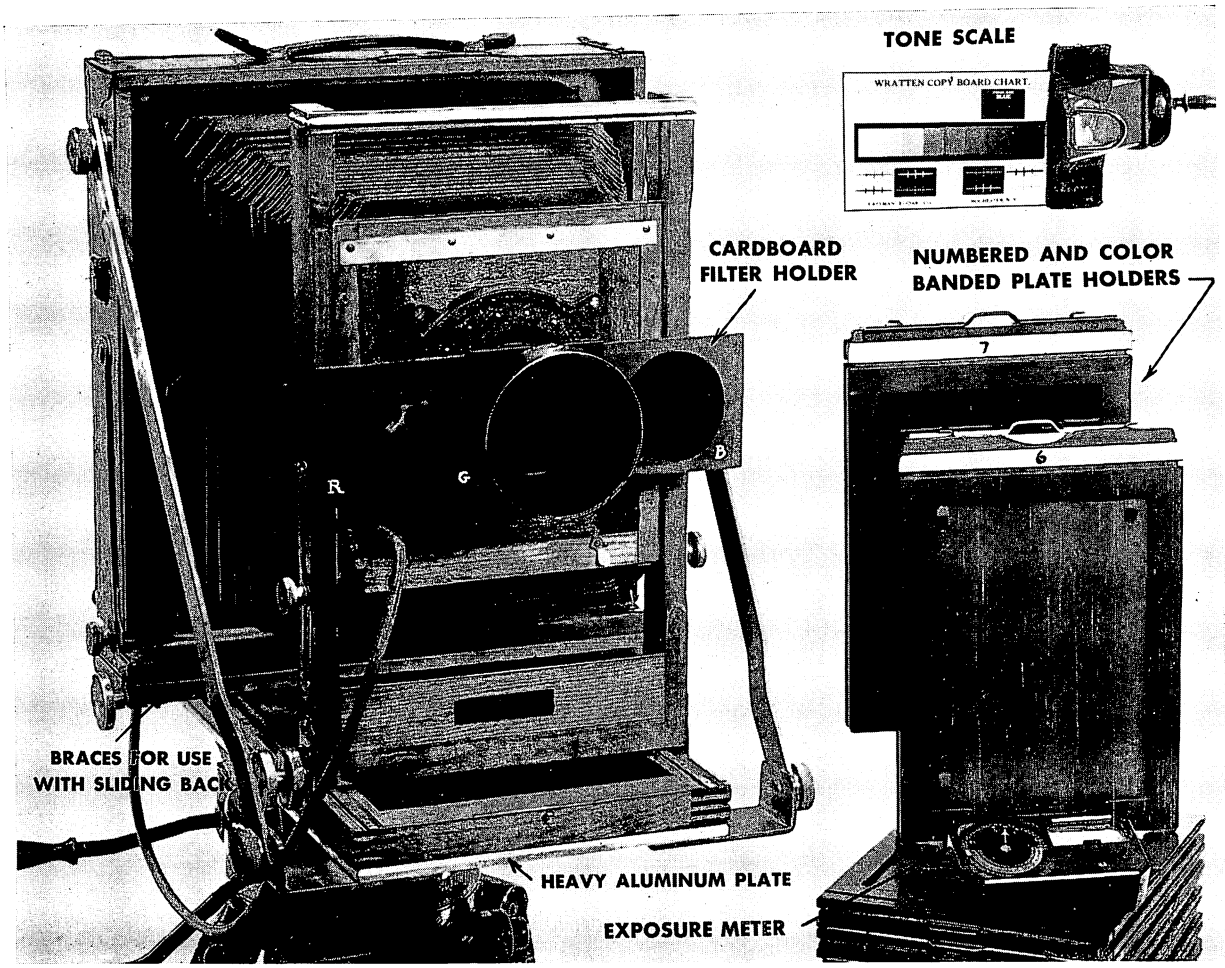


FIG. 2—View camera with specially made lens hood which accommodates gelatin filters mounted in a cardboard slide. Tone scale, plate holders, and exposure meter.

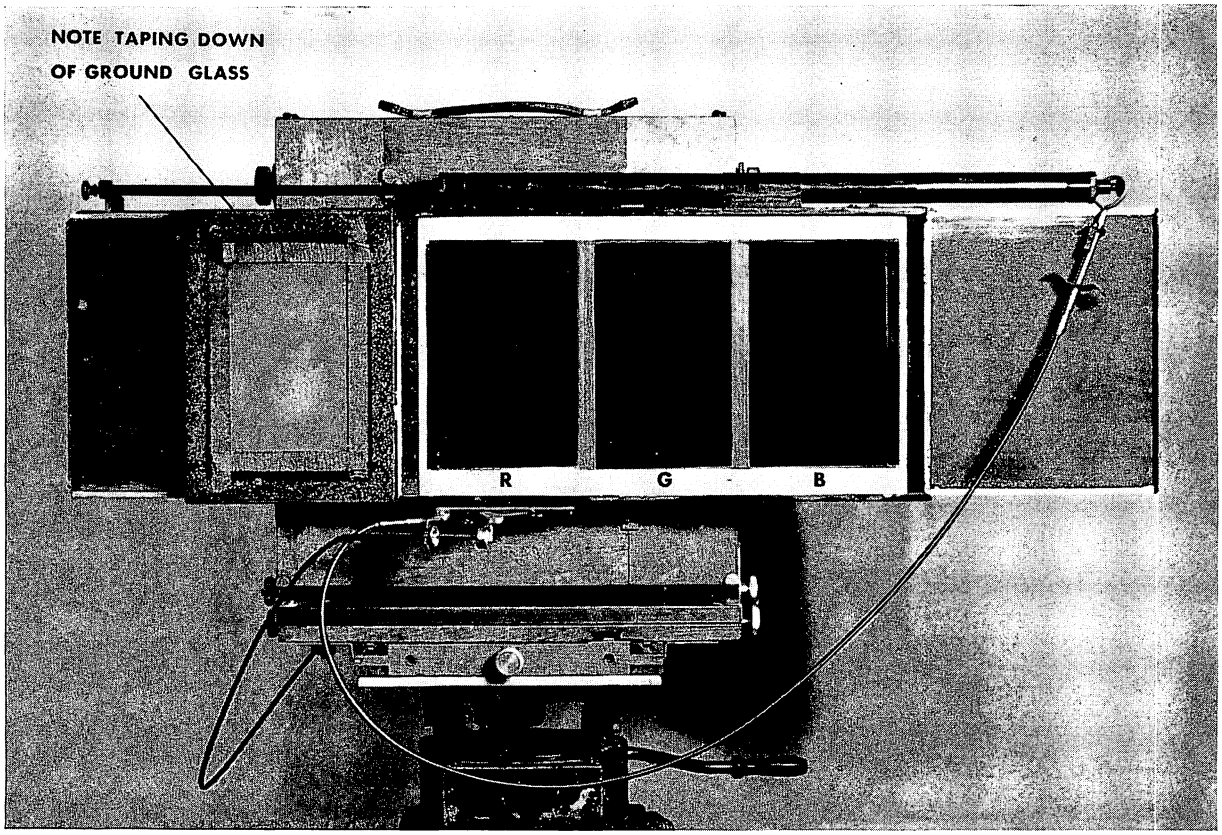


FIG. 3—Sliding back mounted on view camera, plate holder is removed to show arrangement of filters which slide across successively after ground glass. Shutter and back synchronized.

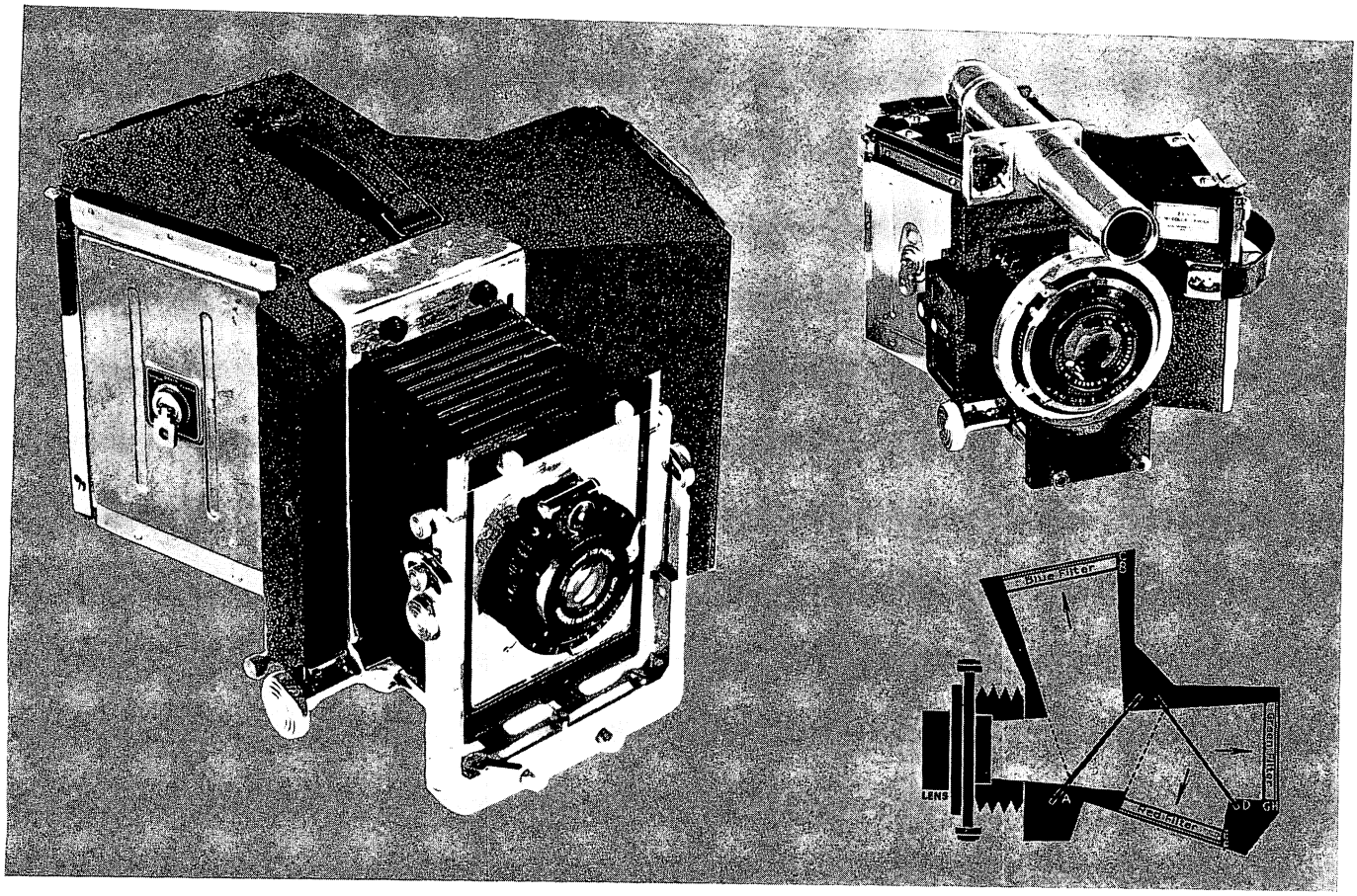


FIG. 4—Devin 5 x 7 in. and 6.5 x 9 cm. double-mirror, one-shot cameras shown in relative size; diagram illustrates mirror arrangement.

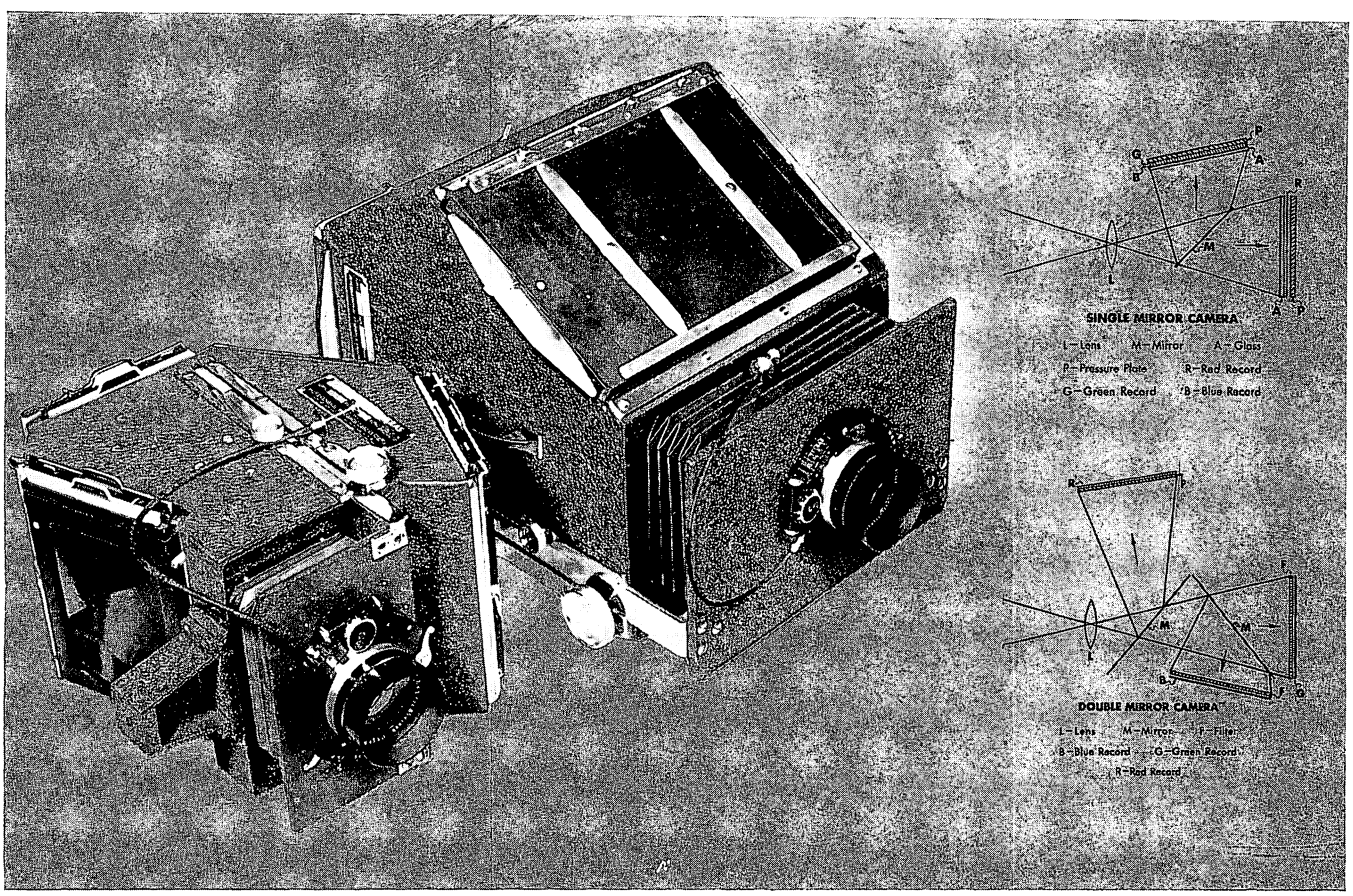


FIG. 5—Lerochrome 3¼ x 4¼ in. double-mirror and 5 x 7 in. single mirror one-shot cameras shown in relative size; diagram indicates arrangement of mirrors and splitting of light beam in single- and double-mirror cameras.

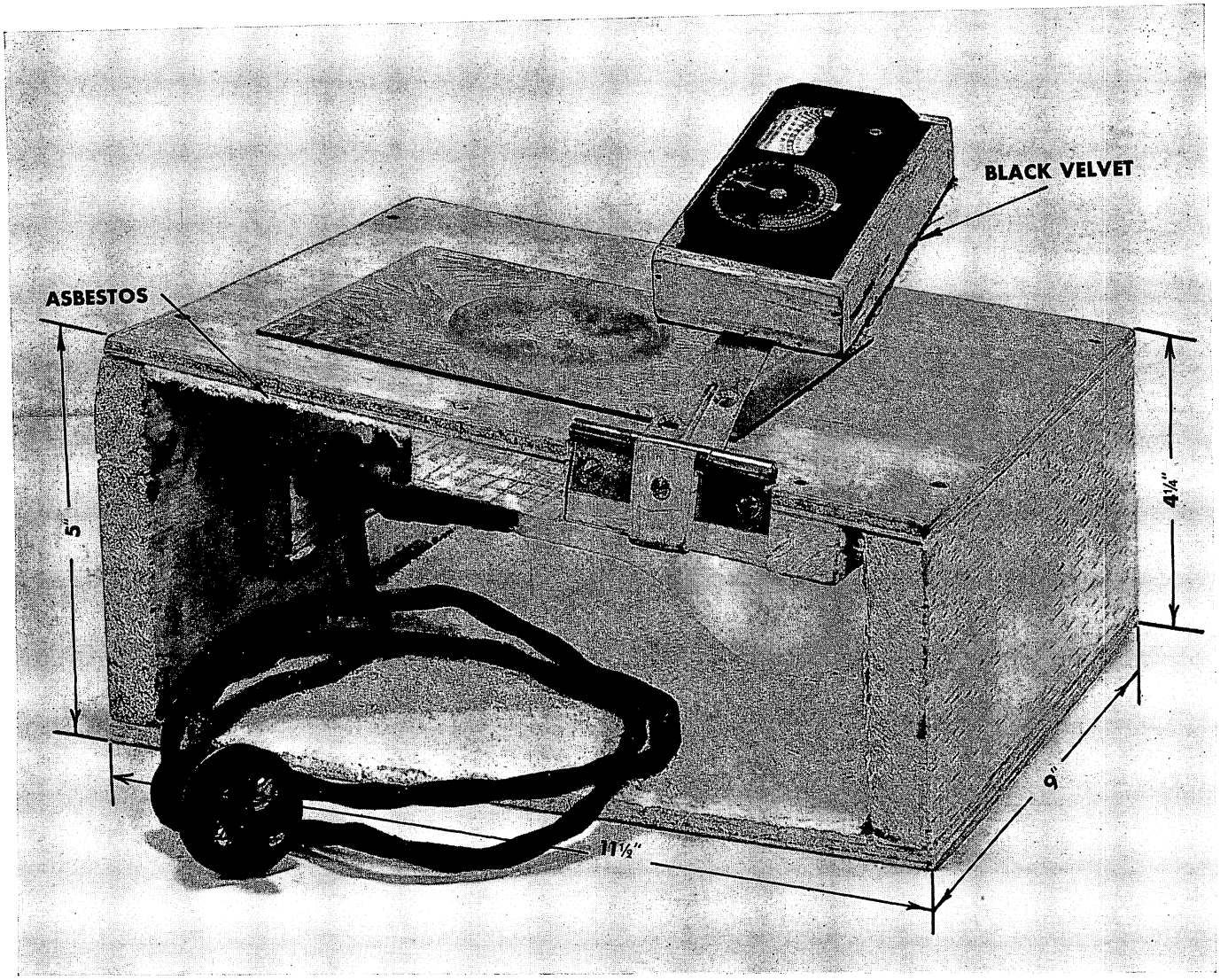


Fig. 6—Home made densitometer using No. 2 photoflood and Weston Universal exposure meter.

CONVERSION TABLE — WESTON READINGS TO DENSITY

Weston	Density	Weston	Density	Weston	Density	Weston	Density
.80	2.09	7.00	1.15	20.00	.70	36.00	.46
.90	2.03	8.00	1.09	22.00	.66	38.00	.42
1.00	2.00	9.00	1.03	22.50	.65	40.00	.40
1.30	1.88	10.00	1.00	23.00	.64	43.00	.37
1.60	1.81	11.00	.95	25.00	.60	45.00	.35
2.00	1.70	12.00	.92	26.00	.59	48.00	.32
2.50	1.60	13.00	.88	27.00	.58	50.00	.30
3.20	1.55	14.00	.85	28.00	.56	53.00	.27
3.50	1.49	15.00	.83	29.00	.55	55.00	.26
4.00	1.40	16.00	.81	30.00	.52	58.00	.25
4.50	1.35	17.00	.80	31.00	.52	60.00	.22
5.00	1.30	18.00	.76	32.00	.51	65.00	.19
6.00	1.21	19.00	.72	34.00	.48	70.00	.16

NOTE: The light from the No. 2 photoflood bulb through the 3/16 in. hole should cause the Weston meter needle to read 100 when no negative is in place. This reading of 100 must be checked from time to time, and kept constant, or your negative readings will have no value. Photoflood bulbs blacken quite quickly and you will find it necessary to turn the bulb around to a fresh portion from time to time to maintain the reading of 100.

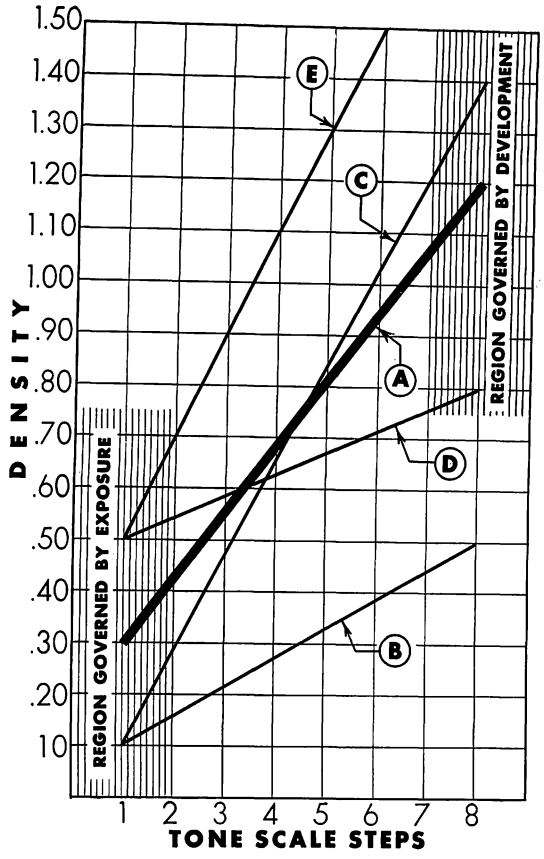


FIG. 7—Over- and underexposure and over- and underdevelopment contrasted with correct exposure and correct development.

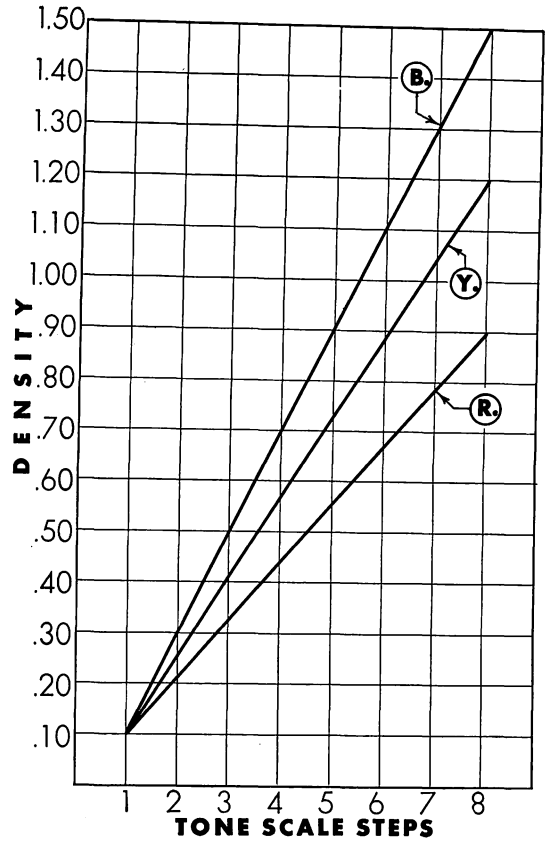


FIG. 8—A set of incorrectly developed separation negatives that is practically unprintable.

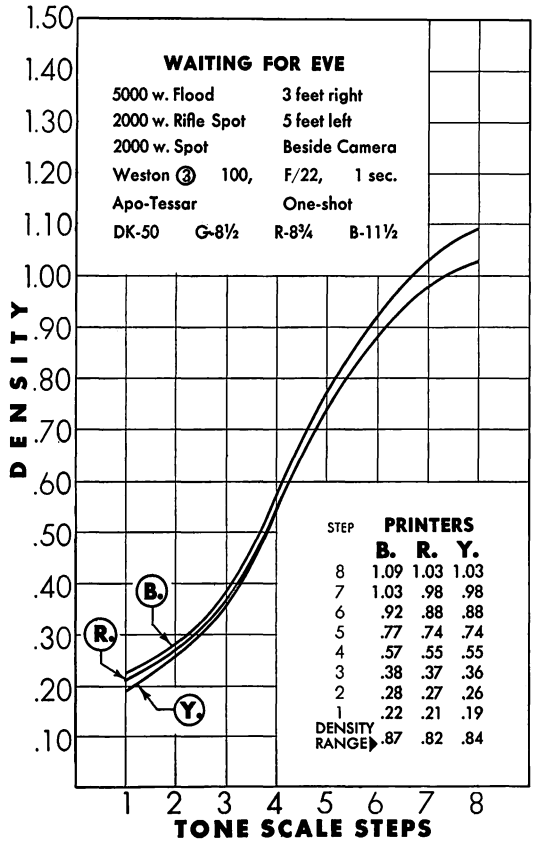


FIG. 9—A nearly perfect set of separation negatives.

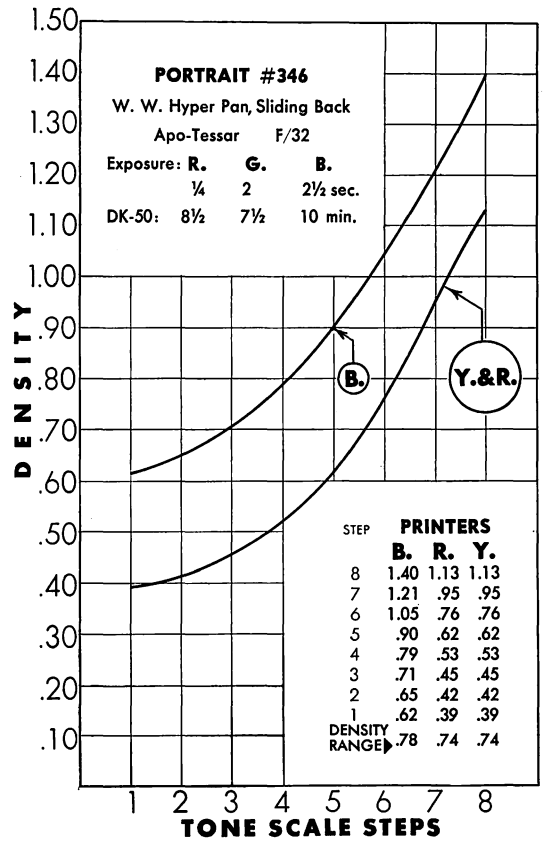


FIG. 10—Incorrectly exposed but properly developed separation negatives, a good print is possible due to similar density ranges.

(See pages 103-105)

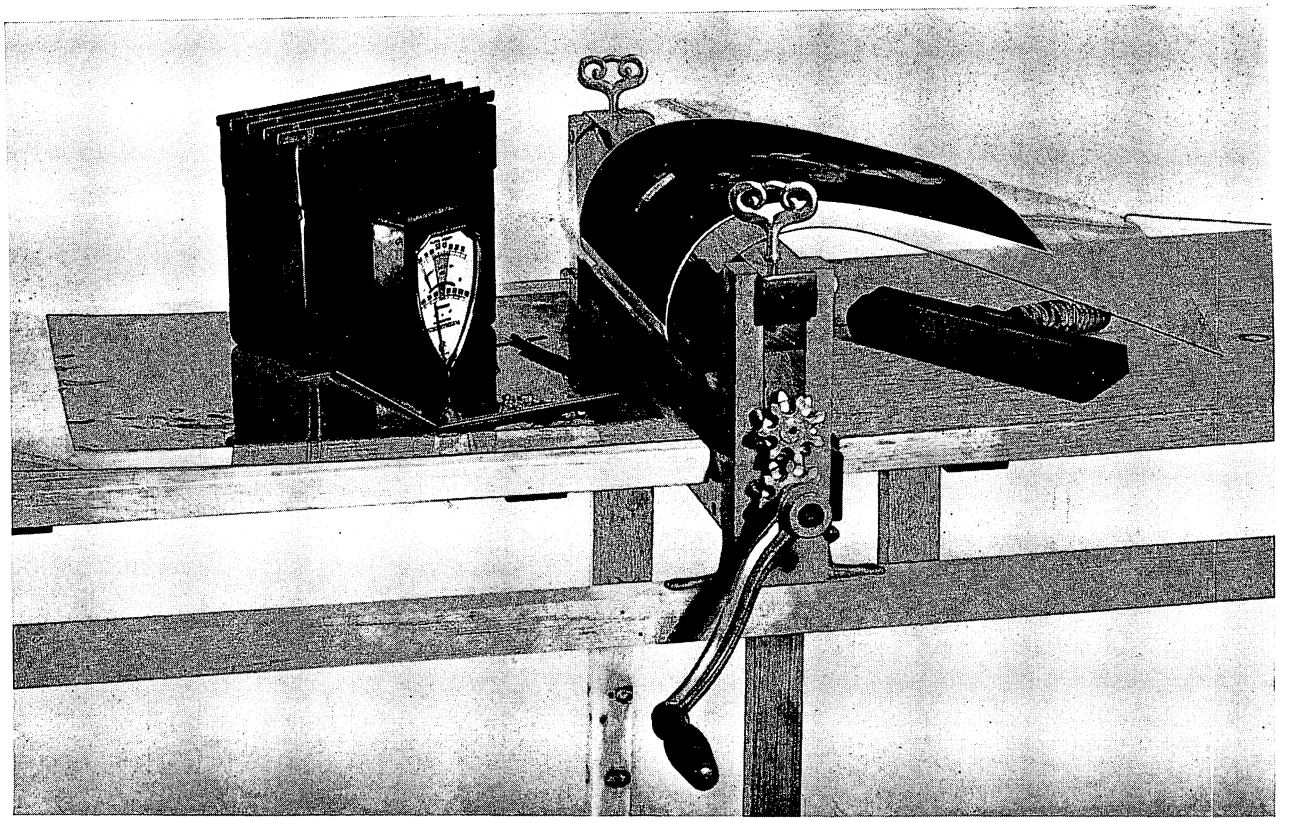


FIG. 11—Flat type, No. 320 Anchor Brand Penn Easy Photo Wringer, showing method of combining wet bromide and pigmented tissues. One-gallon hard rubber tank and Core hangers for developing negatives, humidity and temperature meter, and hand roller for Carbro.

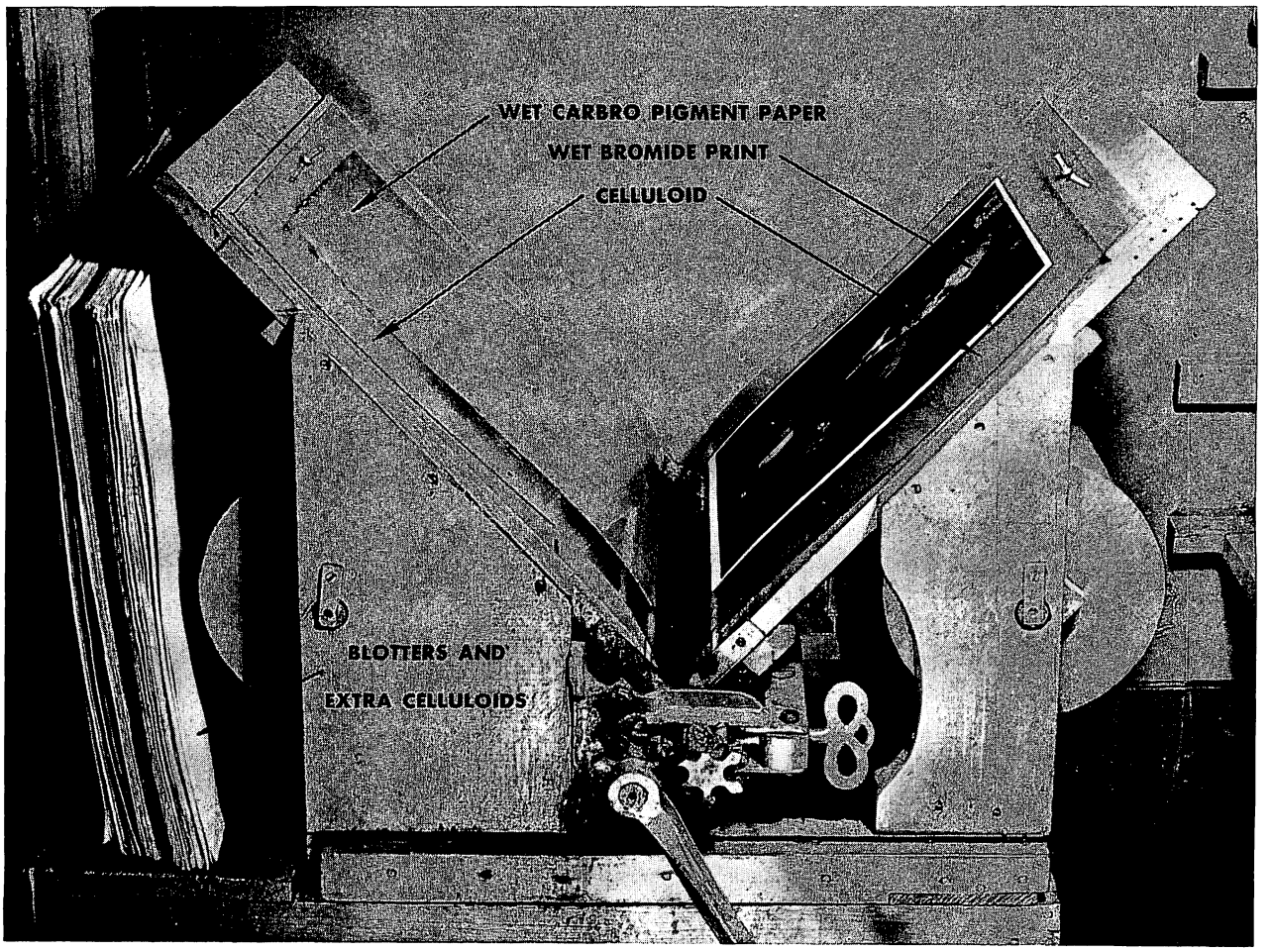


FIG. 12—V-type, No. 420 Anchor Brand Penn Easy Photo Wringer, showing .040 in. combining celluloids pinned to board with push pins; blotters.

FIG. 13—The laboratory.

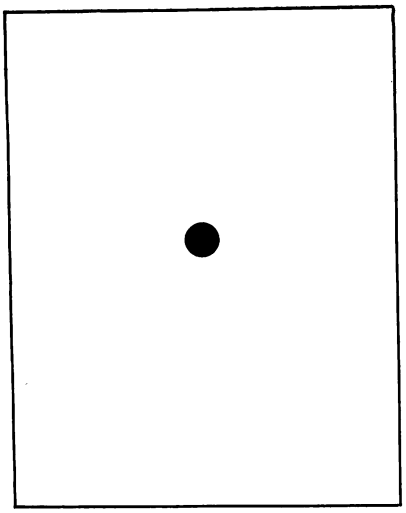


FIG. 14—Interesting placement of a spot within a given area.

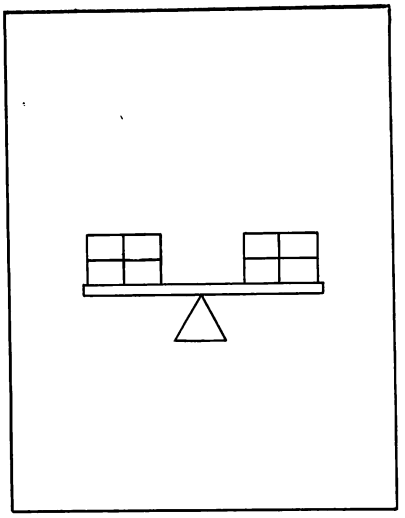


FIG. 15—Formal balance.

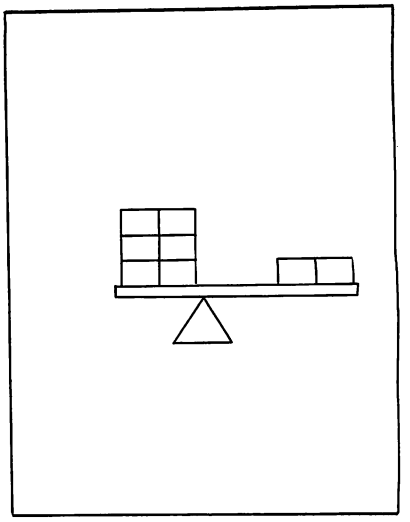


FIG. 16—Asymmetrical balance.

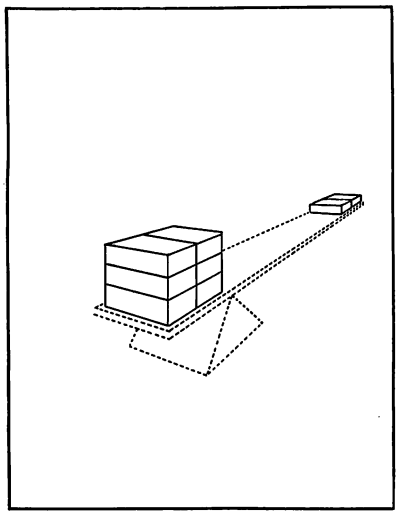


FIG. 17—Asymmetrical balance in perspective.

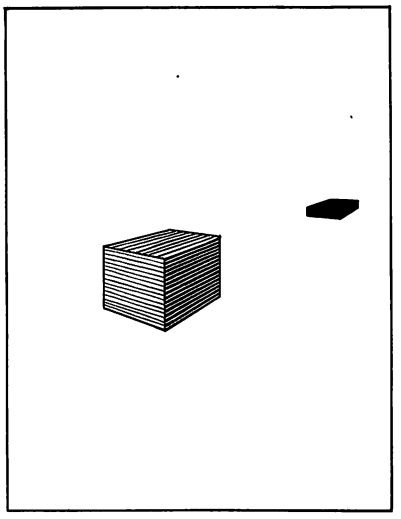


FIG. 18—Balance achieved through intensity of tone in addition to placement.

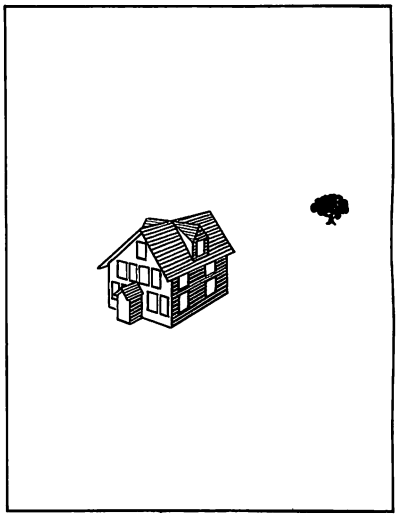


FIG. 19—A more realistic development of Figure 18.

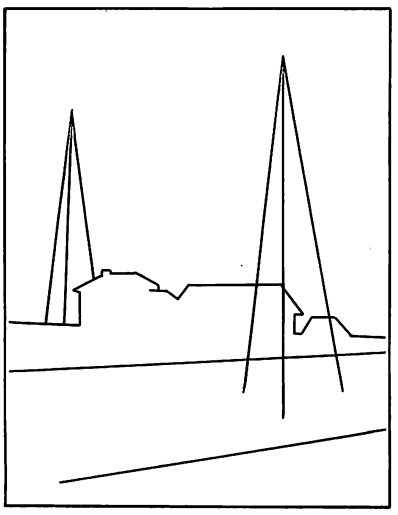


FIG. 20—Verticals and horizontals.
(see Plate 12, p. 137)

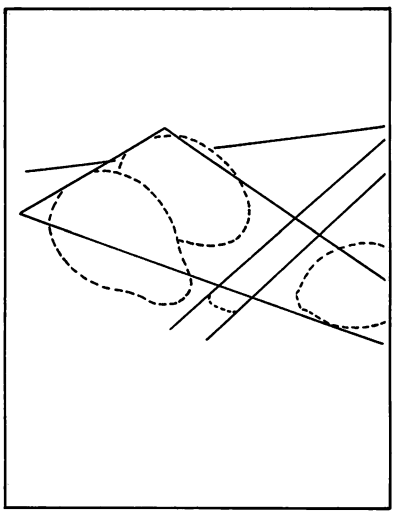


FIG. 21—Angular composition.
(see Plate 5, p. 51)

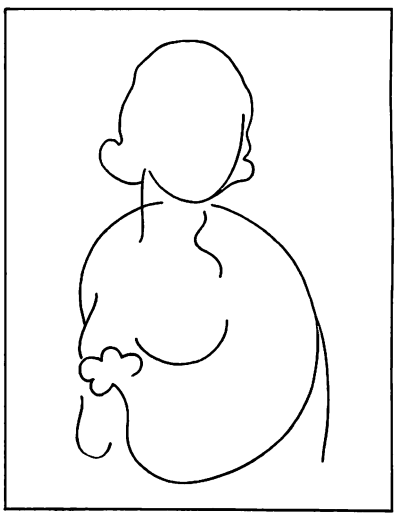


FIG. 22—Circular composition.
(see Plate 9, p. 99)

(See Chapter 4, p. 48)

NEGATIVE PROCESSING FORMULAS

NOTE: Dissolve all chemicals in the order given. All processing should be done at 65°F. (except with Edwal-12).

DEVELOPERS

D-76

Water (125°F.)	96	ounces
Elon	116	grains
Sodium Sulphite (desiccated)	13¼	ounces
Hydroquinone	290	grains
Borax (granular)	116	grains
Water to make	1	gallon

Excellent for most separation negatives, except very high speed one-shot camera plates. Gives low contrast, fine grain, and maximum shadow detail.

Dry—1 gal. size ..... $ .60

DK-76

Water (125°F.)	96	ounces
Elon	116	grains
Sodium Sulphite (desiccated)	13¼	ounces
Hydroquinone	290	grains
Kodalk	400	grains
Water to make	1	gallon

Suitable for higher speed emulsions and certain one-shot camera plates, like Ilford Hyper Pan.

DK-50

Water (125°F.)	64	ounces
Elon	145	grains
Sodium Sulphite (desiccated)	4	ounces
Hydroquinone	145	grains
Kodalk	1 ounce, 145	grains
Potass. Bromide	29	grains
Water to make	1	gallon

Brings up proper strength and punch in one-shot camera plates like the Devin.

Dry—1 gal. size ..... $ .45

EDWAL-12

Gives much finer grain than any other developers listed here, without loss of exposure speed with very high-speed emulsions.

Dry—1 gal. size $1.75
Liquid—1 gal. size 3.75

INTENSIFIERS

VICTOR INTENSIFIER

5-10 seconds for slight intensification. 5 minutes for maximum intensification. 15-45 seconds is what will usually be found necessary for balancing sets of separations.

Ready-made in powder form

3 sizes ..... $.25-1.00

PROPORTIONAL NEGATIVE INTENSIFIER

Soak plates for 2 hours in very cold water. Then soak for 5 minutes in the following solution:

Water	64	ounces
Formaldehyde	1¾	ounces
Carbonate	⅔	ounce
Water to make	1	gallon

Rinse and fix for 5 minutes in fresh acid fixing bath.

Wash for 1 hour.

While still wet, bleach in the following solution for 2 minutes (not over 65°F.):

Potass. Bichromate	1	ounce
Hydrochloric Acid	¾	ounce
Water to make	1	gallon

Rock constantly during bleaching and examine in oblique light until transparent.

Wash for 10 minutes.

Redevelop in D-72 diluted 1-2 for from 3 to 10 minutes.

When no more yellow shows in the negatives, maximum intensification will have been achieved.

Fix for 5 minutes.
Wash for ½ hour and dry.

REDUCER FOR ABOVE

If intensification has been carried too far, the following bath will reduce the negatives:

Water	35	ounces
Hydrochloric Acid	1⅔	ounces

Rock in tray until right amount of reduction is obtained—then stop action by washing in water.

FIXING BATHS

F-5

Water (125°F.)	80	ounces
Hypo	2	pounds
Sodium Sulphite (desiccated)	2	ounces
Acetic Acid (28%)	6	ounces
Boric Acid (crystals)	1	ounce
Potass. Alum	2	ounces
Cold water to make	1	gallon

NOTE: 3 parts Glacial Acetic Acid to 8 parts water equals 28% Acetic Acid.

KODAK ACID FIXING POWDER

Ready-made in package form

—1 pound makes 64 ounces . $ .25
Convenient for travelling and excellent for general use. Because it is less trouble to mix, I have used this fixing bath with all kinds of negatives for years.

GENERAL HINTS

All negative material should be lightly and carefully wiped off under the tap with a wad of cotton saturated with water. It is advisable to wipe surface-dry, with a viscose sponge, the first plate of a set of separation negatives after the third one has been put to drain. This will decrease the chance of draining marks. Certainly never allow more time to elapse before wiping dry with the sponge than that required for putting six plates up to drain. All plates and films should be drained and dried in the same position.

When making trial sets of separation negatives for testing exposure and development by way of bringing negatives into the best possible balance, after removal from the fixing bath, the plates may be force washed by being held under the tap for five minutes, then rocked in a tray of pure alcohol for a minute or two before being placed to dry. This will diminish considerably the time required for securing desired information, where permanence of the negative material is not a requisite.

FORMULAS FOR THE DUFAYCOLOR PROCESS

NOTE: All processing should be done at 65°F.

FIRST DEVELOPER

Metol	16	grains
Hydroquinone	128	grains
Sodium Sulphite, dry	1¾	ounces
Sodium Carbonate, dry	1¼	ounces
Potassium Bromide	80	grains
Potassium Thiocyanate	144	grains
Water	35	ounces

Develop 5 minutes at 65°F.

STOP BATH

Water	35	ounces
Acetic Acid (28%)	1¾	ounces

or 2% Solution of Glacial Acetic Acid may be used

BICHROMATE BLEACH

Water	35	ounces
Potassium Bichromate	80	grains
Sulphuric Acid	160	minims

(Concentrated, commercial, specific gravity 1.87)

HARDENING BATH

Formalin (40%)	1	ounce
Caustic Soda	24	grains
Sodium Sulphate	5¼	ounces
Water	35	ounces

This bath must be used only if processing temperatures are over 70°F.—otherwise omit.

PERMANGANATE BLEACH

Water	35	ounces
Potassium Permanganate	48	grains
Sulphuric Acid	160	minims

(Concentrated commercial, specific gravity 1.87)

This bleach gives most brilliant colors, but must not be used over 70°F.

CLEARING BATH

Sodium Bisulphite, or Potassium Metabisulphite	400	grains
Water	35	ounces

Used to remove stain and followed by Second Exposure.

SECOND DEVELOPER

Metol	32	grains
Hydroquinone	144	grains
Sodium Sulphite, dry	2¾	ounces
Sodium Carbonate, dry	1¾	ounces
Water	35	ounces

FIXING BATH

Hypo	14	ounces
Potassium Metabisulphite	½	ounce
Water	35	ounces

Dissolve separately and add:

Chrome Alum	160	grains
Water	35	ounces

If any loss of density occurs after this bath, omit in future and simply wash.

Si-Mi may be used or this:

CHEMICAL REVERSAL BATH

in place of Second Exposure and Developer (mainly for M. P. Film)

Sodium Hydrosulphite	½	ounce
Sodium Bisulphite	160	grains
Water	35	ounces

INTENSIFICATION

Films should first be bleached in the following bath:

BLEACHING BATH

Ammonium Chloride	360	grains
Mercury Bichloride	450	grains
Water	35	ounces

The image should be bleached to completion, which takes approximately 4 minutes. It is then washed for 15 minutes, and redeveloped in either of the formulas below, according to the degree of intensification needed:

FOR MODERATE INTENSIFICATION

Sodium Sulphite, dry	1¾	ounces
Water	35	ounces

FOR CONSIDERABLE INTENSIFICATION

Ammonia	1¾	ounces
Water	35	ounces

REDUCING SOLUTION

A

Hypo	1¾	ounces
Sodium Carbonate, dry	½	ounce
Water	35	ounces

B

Potassium Ferricyanide	80	grains
Water	35	ounces

(For use, mix equal parts of A and B)

All the solutions keep well in bottles except the Bleach and Chemical Reversal Bath. These two baths must be freshly prepared before use.

TIME-TABLE—DUFAYCOLOR PROCESS

	Time in Minutes
Immerse in First Developer—rock tray constantly	5
(at 65°F., 4½ min. at 68°F., 4 min. at 70°F.)	
Wash in running water	1
Place in Bleaching Bath—rock tray constantly (light may be turned on after 2 minutes)	4
Wash	2
Immerse in Clearing Bath	2
Wash (image may be seen in color)	2
Expose 1 ft. from 100 watt lamp	1-2
Develop in Second Developer—rock tray	4
Wash	1
Immerse in Fixing Bath	5
Wash	15
Dry	15

Total Theoretical Processing Time—57 Minutes

MATERIALS FOR THE DUFAYCOLOR PROCESS

Tank or tray of suitable size for:
- First Developer
- Bleaching Bath
- Clearing Bath
- Second Developer
- Fixing Bath
- Washer
- Reversal Bath (if Reversal Bath is used in place of Second Exposure)

Bottles of suitable sizes for keeping solutions.

A sufficient number of Film Hangers of suitable size:
4 x 5 in., 5 x 7 in. ..... $ .65 each
8 x 10 in. ..... 1.13 each

Kodak Safelight with Wratten Series 3 Green Screen $3.60

Miniature Trial Kit, consisting of Developer and Bleach $1.25

Materials and information for the Dufaycolor Process may be obtained from Dufaycolor, Inc., 30 Rockefeller Plaza, New York City; likewise from your local dealer. Be sure to get the Dufaycolor Manual before commencing work.

PRICE OF DEVELOPING DUFAY FILM

Roll film—per roll	$ .50
Film pack—per pack	1.00
Cut film—per sheet up to 4 x 5	.25
Cut film—per sheet 5 x 7	.35
Cut film—per sheet 8 x 10	.50

The Dufay Company will make contact prints for from 1⅝ x 2½, $.75 to 8 x 10, $6.50 for a single print. For extra prints on one order the price runs from $.50 for the smallest size to $3.00 for the 8 x 10.

You may also have enlargements made for from 2¼ x 3¼, $2.50 to 8 x 10, $10.00 for a single print. For extra prints on one order the price runs from $1.00 for the smallest size to $3.50 for the 8 x 10.

FORMULAS FOR THE CHROMATONE PROCESS

Develop negatives to a gamma or contrast of .75

NORMAL CHROMATONE DEVELOPER 55-D

Water	32	ounces
Metol	36	grains
Sodium Sulphite (desiccated)	1¼	ounces
Hydroquinone	144	grains
Sodium Carbonate (desiccated)	1¼	ounces
Potass. Bromide	60–144	grains

For use take 1 part of stock solution and add 2 parts water. Develop 1½ or 2 minutes at 70°F.

SOFT CHROMATONE DEVELOPER 59-D

(For good prints from hard negatives)

Water	32	ounces
Metol	44	grains
Sodium Sulphite (desiccated)	1 ounce 88	grains
Sodium Carbonate (desiccated)	263	grains
Potass. Bromide	58	grains

For use take 1 part stock solution and add 3 parts water. Develop 3 to 4 minutes at 70°F.

VIGOROUS CHROMOTONE DEVELOPER 15-D

(For good prints from very soft negatives)

A

Water	32	ounces
Hydroquinone	1½	ounces
Sodium Sulphite (desiccated)	1	ounce
Sulphuric Acid	1	dram

B

Water	32	ounces
Sodium Carbonate (desiccated)	4	ounces
Potass. Bromide	120	grains
Sodium Sulphite (desiccated)	3	ounces

Use equal parts A and B. Develop 5 minutes at 70°F.

FIXING BATH

Water	64	ounces
Hypo	1	pound
Potass. Metabisulphite	1	ounce

Should be on cool side.

THIOCYANATE FIXING BATH 9-F

Potass. Thiocyanate	100	grams
Potash Alum	50	grams
Water	1000	cc.
Glacial Acetic Acid	25	cc.

When extreme speed of operation is necessary, as following this bath, much less thorough washing will do.

FOR MATT SURFACE PRINTS

For removing high gloss finish from print surface use Acetone, let stand on print for 2 or 3 minutes then squeegee off.

WORKING SOLUTIONS FOR CHROMATONE COLOR PRINTS

Red and Blue Toner A Working Solution

Water	1	ounce
Red and Blue Toner A	1	ounce
Standard Ferricyanide Sol.	1½	drams

This solution does not keep well when mixed. Mix only amount needed.

Yellow Toner A Working Solution

Yellow Toner A No. 1	1	ounce
Yellow Toner A No. 2	1	ounce
Standard Ferricyanide Sol.	1½	drams

Add No. 1 to No. 2, stirring until precipitate is completely dissolved. As this solution does not keep well when mixed, mix only amount needed. After toning for 10 minutes, pour solution into graduate and add to it 3 drams of Standard Hypo Solution. Wash print in running water for 1 minute and pour Toner back on print. Continue toning for another 3 minutes.

B Toners

Red, Blue, and Yellow B Toners are used without dilution or addition, and they may be used more than once provided great care is employed to prevent contamination.

THE THREE STANDARD SOLUTIONS NEEDED

(They keep well properly bottled)

Standard Ferricyanide Solution

Potassium Ferricyanide	½	ounce
Distilled Water	4	ounces

Standard Hypo Solution

Granular or Rice Hypo	2¼	ounces
Distilled Water	32	ounces

Wherever the formula calls for STANDARD HYPO SOLUTION, this is the formula that must be used. A bath containing acid or alum will bring complete failure.

Dilute Hydrochloric Acid

Hydrochloric Acid C.P.	16	ounces
Distilled Water	48	ounces

NOTE: Especially where lime is present in the water, the above three standard solutions should be made up with distilled water.

Dilute Hypo Solution

Standard Hypo Solution	1	part
Water	3	parts

TIME-TABLE—CHROMATONE PROCESS

	Time in Minutes
Make Chromatone Print Enlargements (balancing, comparing tone scales, etc.)	30–60
Develop (2 minutes each)	6
Fix	5
Process Yellow First—Alone	
Wash	4
Bleach	10
Rinse	1
Add Standard Hypo Solution and continue bleaching	3
Rinse	1
Fix in Dilute Hypo Solution	1
Wash	4
Tone (Y Toner diluted 1-15)	5
Wash	4
(Leave Yellow in water ready for assembling)	
Now Process Red and Blue	
Wash (each for 4 minutes)	8
Bleach (4 minutes apart) each for	10
Wash (both) (each for 4 minutes)	4
Tone (both)	10
Rinse Blue in Standard Hydrochloric Acid	1
Wash Blue	4
Fix (both)	3–5
Wash (both)	4
Registering and Assembling	15
Dry	60
Total theoretical time with high gloss finish:	3 hours, 15 to 45 min.

MATERIALS FOR THE CHROMATONE PROCESS

Toner Units

Come in 5 sizes from $3.50 to $50

No. 2, for example contains 32 ounces Red and Blue Toner A, 32 ounces Yellow Toner A, and 16 ounces each of Red, Blue and Yellow Toner B. It is sufficient to tone 32, 5 x 7's, 16, 8 x 10's, or 8, 11 x 14's, or 4, 16 x 20's. Complete set sells for $8.75. There is also a complete trial outfit containing everything for $7.50.

Chromatone Paper

(Collodion Stripping)

5 x 7 in. per doz.	$ 1.15
8 x 10 in. per doz.	2.50
11 x 14 in. per doz.	5.05
14 x 17 in. per doz.	7.55

May be had in all sizes, even to 40 x 60 in.

Safelight, bottles and trays of suitable size, large sheet of plate glass, flat squeegee, Masonite board for mounting finished print, and of course graduates, scales, and general darkroom equipment.

Information and materials for Chromatone Process may be obtained from the Defender Photo Supply Co., Inc., Rochester, N. Y., as well as your local dealer. Get the Chromatone book.

FORMULAS FOR THE CARBRO PROCESS

Develop negatives to a gamma or contrast of about .90.

BROMIDE PRINT DEVELOPERS

Stock Solution D-72

Water (125°F.)	16	ounces
Elon	45	grains
Sodium Sulphite (desiccated)	1½	ounces
Hydroquinone	175	grains
Sodium Carbonate	2½	ounces
Potass. Bromide	27	grains
Water to make	32	ounces

The following dilutions pertain to Illingworth Bromide Paper:

Normal	1 Stock to 4 Water
Soft	1 Stock to 6 Water
Contrast	1 Stock to 2 Water or 1 Stock to 1 Water

Develop for 2 minutes at 70°F.

VARIABLE CONTRAST DEVELOPERS

A (Plain Metol)

Water (125°F.)		30	ounces
Metol		88	grains
Sodium Sulphite (desiccated)	2 ounces	176	grains
Sodium Carbonate	1 ounce	88	grains
Bromide		58	grains
Water to make		64	ounces

Dilute 1 Stock to 3 Water
Extreme Soft Developer
Develop 3-4 minutes at 70°F.

B (Plain Hydroquinone)

Water (125°F.)		30	ounces
Hydroquinone		150	grains
Sodium Sulphite (desiccated)	2 ounces	120	grains
Sodium Carbonate		5½	ounces
Bromide		21	grains
Water to make		60	ounces

Dilute 1 Stock to 2 Water
Extreme Contrast Developer
Develop for 3 minutes at 70°F.

NOTE: For maximum contrast and softness the above developers may be used as indicated, but any degree of contrast may be obtained by intermixing them in different proportions.

55-D

Water (about 105°F.)	28	oz.
Metol	36	grains
Sod. Sulphite (anhydrous)	1¼	oz.
Hydroquinone	144	grains
Sod. Carbonate (anhydrous)	1¼	oz.
(Or Monohydrate)	1	oz. 204 grains
Pot. Bromide	100	grains
Cold Water to	32	oz.

Dilute 1 part developer to 2 parts water.

As Devin Bromide Paper is more contrasty than Illingworth for softer and more controllable results use double the quantity of Metol and half the quantity of Hydroquinone indicated in the above formula. For still softer results, use plain Metol.

ACETIC ACID SHORTSTOP

Water	50	ounces
Acetic Acid	1	ounce

(2% Solution: 2 ounces in 100 of Water)

FIXING BATH

(Bromides)

Water (warm)	3	gallons
Hypo	4	pounds
Metabisulphite	1	pound
Add cold water to make	5	gallons

HYPO TESTING SOLUTION

Potassium Permanganate	4	grains
Sodium Hydroxide	8	grains
Water (distilled)	8	ounces

Dilute 15 drops in a 2 ounce graduate, pour half into another 2 ounce graduate, fill remainder of one with water, the other with drippings from bromides. If contents of bromide dripping graduate changes color, there is still Hypo in the prints.

SINGLE BLEACH BATH (DEVIN)

A

Potassium Ferricyanide	1 ounce	334	grains
Potassium Bromide	1 ounce	334	grains
Ammonium Bichromate		231½	grains
Water (not over 75°F.)		35	ounces

B

Chromic Acid Flakes		154.3	grains
Water		35	ounces

C

Formaldehyde	1¾	ounces
Water	35	ounces

Mix together 14 ounces of A, 7 to 8 ounces of B, and 40 cc. of C in 70 ounces of water. (For 11 x 14 to 14 x 17 prints.) (Increase B about 15 percent for National Photocolor Pigment Paper.)

DOUBLE BLEACH BATH FOR AUTOTYPE

I—Newens Formula

Potass. Ferricyanide	1	ounce
Potass. Bromide	1	ounce
Potass. Bichromate	1	ounce
Water	20	ounces

II

Water	12	drams
Glacial Acetic Acid	1	dram
Hydrochloric Acid	1	dram
Formaldehyde	10	drams

In hot weather omit water and increase Formaldehyde to 22 drams.

Use 1 ounce of No. 1 to 4 ounces Water.

Use 1 ounce of No. 2 to 48 ounces Water for second bath. Soaking time, 2 to 3 minutes, drain 15 seconds; 3 minutes in No. 1; drain 15 seconds; then 30-40 seconds in No. 2.

CURE FOR LIME IN WATER AND LOSS OF HIGHLIGHTS

2% Acetic Acid Solution, or Distilled Water—Swab off bromides with thick wad of cotton, especially in the highlights.

REMOVING COLORING FROM CELLULOIDS

1 quart bottle of Clorox and 64 oz. water
Leave celluloids in this for a minimum of 6 hrs., or until all color has disappeared, then wash thoroughly.

BICHROMATED ALBUMEN FOR CELLULOIDS

Beat white of one egg, add to 15 ounces cold water. In 5 ounces of warm water dissolve 150 grains of Potassium Bichromate, add to the egg and water. Mix thoroughly, filter through cheesecloth. Immerse celluloids in this bath, hang to dry in the light, being careful entire surface receives coating of Albumen. They are then ready for use. This is best insurance against frilling known, but is seldom needed these days.

TIME-TABLE—CARBRO PROCESS

	Time in Minutes
Make Bromide Enlargements (measuring, comparing tone scales, etc.)	30–60
Develop Bromides (2 minutes each) ... together	6
or separately	9
Fix Bromides (fresh Hypo)	15
Wash Bromides (Eastman Siphon Tray Washer)	60
Swab Bromides in Acetic Acid	2
Dry Bromides	20
Retouch Bromides	15–60
(Soak Bromides 10 minutes while doing the following four steps)	
Assemble Pigmented Paper	1
Soak Pigmented Paper in water	3
Hang Pigmented Paper to drain	3
Soak Pigmented Paper in Bleach Bath	3
Put Tissue and Bromides through wringer	3
Set Sandwiches (10 minutes from completion of first Sandwich)	8
Pull Sandwich apart in water or alcohol bath and place Pigmented Paper on Celluloid	5
Squeegee	
Roll between blotters (1¾ minutes each)	

	Time in Minutes
Leave in blotters	8
Develop in hot water	18
Dry Images on Celluloid	30
Examine for color balance	2–3
Soak Temporary Support	5
Soak Blue Celluloid	5
Squeegee and roll in blotters	1½
Dry	30
Clean with Turpentine	1–2
Soak Blue and Red Images	5–7
Register	15–30
Dry	30
Clean with Turpentine	1–2
Soak Purple and Yellow Images	5
Register	10–20
Dry	30
Clean with Turpentine (and trim Temporary)	2
Soak Final Support in hot water	10
Soak Temporary and Final in cold water	2
Squeegee and roll, then cover with Plate Glass	30
Develop in hot water	2
Chill in cold water	1
Drain and paste on board to dry	30

Total Theoretical Time: 9 hours 20½ minutes

MATERIALS FOR THE CARBRO PROCESS

BROMIDE PAPERS

ILLINGWORTH NORMAL CONTRAST BROMIDE

Rolls

10 yds. x 40 in.	$21.00
10 ft. x 40 in.	7.50

Cut Sheets, per doz.

11 x 14 in.	$ 2.75
8 x 10 in.	1.50

DEFENDER VELOUR BLACK

(necessitating 15% heavier printing)

8 x 10 in. per doz.	$ 2.88
10 x 12 in. per doz.	4.32
11 x 14 in. per doz.	5.76
14 x 17 in. per doz.	8.56
16 x 20 in. per doz.	11.52

SPECIAL SINGLE CARBRO BLEACH BATH

FOR DEFENDER PAPER

A

Potassium Ferricyanide	2 ounces
Potassium Bromide	2 ounces
Ammonium Bichromate	262 grains
Water	40 ounces

B

Chromic Acid Flakes	140 grains
Water	32 ounces

C

Formaldehyde	2 ounces
Water	20 ounces

Mix together 10 ounces of A, 4½ to 5 ounces of B, and 1½ ounces of C in 55 ounces of water. Sensitize 3 minutes at 50°F. to 55°F.

DEVIN BROMIDE PAPER

	1 Doz.	½ Gross	1 Gross
8 x 10	$ .95	$ 4.95	$ 9.20
11 x 14	1.75	9.25	17.55
14 x 17	2.65	14.15	26.80
16 x 20	3.45	18.70	35.90

Rolls

10 foot x 40 inches	$ 4.75
10 yards x 40 inches	12.15

TRICOLOR PIGMENT PAPER

DEVIN COLORGRAPH CO.

Rolls

10 ft. x 20 in.	$ 3.50
5 ft. x 20 in.	1.90

Cut Sheets, per doz.

10 x 12 in.	2.25
13 x 16 in.	3.75

AUTOTYPE

Rolls

12 ft. x 30 in.	$ 7.00

Cut Sheets, per doz.

8 x 10 in.	2.50

SOLUBLE TEMPORARY SUPPORT PAPER

DEVIN COLORGRAPH CO.

Rolls

10 ft. x 20 in.	$ 1.50
5 ft. x 20 in.	.85

Cut Sheets, per doz.

13 x 16 in.	$ 1.75
10 x 12 in.	1.00

AUTOTYPE

Rolls

12 ft. x 30 in.	$ 3.25

TRIAL CARBRO KITS

All 8 x 10 in. size.

George Murphy Autotype	$10.00
Devin Colorgraph	8.50
National Photocolor	8.50

FINAL SUPPORT PAPER

DEFENDER MATT N

Rolls

10 yds. x 30 in.	$ 3.70
10 ft. x 30 in.	1.50

AUTOTYPE No. 116

Rolls

12 ft. x 30 in.	$ 4.00

ANCHOR BRAND PHOTO WRINGER

No. 320

20 in. rollers	$18.00
Complete outfit with blankets	35.00

CELLULOIDS

CELLULOID CORP. OF AMERICA

Cut Sheets .04, about 20 x 50 in. ..... each $ 3.00

DEVIN COLORGRAPH CO.

Cut Sheets, each

18 x 22 in. with holes punched	$ 4.50
16 x 20 in. with holes punched	2.75
10 x 20 in. with holes punched	.50

TWO LARGE SHEETS OF PLATE GLASS

Approx. 24 x 30 in.

FLAT SQUEEGEES

12 in. size	$ 1.00
14 in. size	1.40
16 in. size	1.50

AUTOTYPE WAXING COMPOUND CAKE .. .75

AUTOTYPE WAXING SOLUTION
(ready-made) 4 ounce bottle ..... .50

SOFT RUBBER ROLLER $5.00–10.00

WORLD BLOTTERS, LINTLESS, WHITE

19 x 24 in.

100 lbs. (¼ ream)	$ 5.95
120 lbs.	6.50
140 lbs.	7.75

FLANNELETTE FOR CLEANING CELLULOIDS

BOARD FOR DRYING FINISHED PRINT
Approx. 18 x 24 in.

HOOKS FOR HANGING UP CELLULOIDS

PHOTO CLIPS ..... Per doz. $ .35

SOURCES OF MATERIAL AND PRINTS

The principle sources of supply for the materials used in the Carbro Process are:

George Murphy, Inc., 57 E. 9th St., New York City. (Importer of the Autotype Pigment Paper)

Devin Colorgraph Co., 305 W. 43rd St., New York City.

National Photocolor Corporation, 480 Lexington Ave., New York City.

The Tri-Color Print Service, Inc., 323 E. 47th St., New York City, will make Carbro prints from separation negatives as follows: 8 x 10, $50; 11 x 14, $60; 14 x 17, $70.

MATERIALS FOR THE WASH-OFF RELIEF PROCESS

EASTMAN WASH-OFF RELIEF FILM

5 x 7 per doz.	$ 1.60
6½ x 8½ per doz.	2.45
8 x 10 per doz.	3.55
10 x 12 per doz.	6.20
11 x 14 per doz.	8.90
14 x 17 per doz.	15.10

KODABROM NO. 3 (optional)

For making tone scale tests. It has about the same contrast as that of Relief Film.

5 x 7 per doz.	$ .35
6½ x 8½ per doz.	.55
8 x 10 per doz.	.75
11 x 14 per doz.	1.40

EASTMAN IMBIBITION PAPER (double)

5 x 7 per doz.	$ .30
6½ x 8½ per doz.	.50
8 x 10 per doz.	.70
10 x 12 per doz.	1.00
11 x 14 per doz.	1.25
14 x 17 per doz.	1.90

DYES

EASTMAN DYES

1 vial each of Dyes A, B, and C, or A, B, and CK (each sufficient to make 500 cc. of solution) Per set ..... $ 2.00

1 ounce bottles of any of Dyes A, B, and C or CK (each sufficient to make about 5000 cc. of solution). Per bottle 1.50

CURTIS DUFAYCOLOR DYES

Per set of three, including Buffer ..... $ 6.00

TRI-CHROME DYES

1 quart of Yellow, Red, Blue and restrainer	$ 2.00
1 gallon of Yellow, Red, Blue and restrainer	5.00
2 gallons of Yellow, Red, Blue and restrainer	8.00

The above all shipped in concentrated form.

BOTTLES OF SUITABLE SIZE FOR THE FOLLOWING:

1 doz. for Dye Baths	1 for Developer
2 for Bleach	1 for Ammonia Solution
1 for Hypo	1 for Acetic Acid Solution

KODAK SAFELIGHT

5 x 7 with Wratten O or OA Screen

TWO SHEETS OF PLATE GLASS

Approx. 24 x 30 inches

THREE TRAYS OF SUITABLE SIZE FOR:

Dye Baths

TANKS OR TRAYS OF SUITABLE SIZE FOR EACH OF THE FOLLOWING:

Developing	Hot Water
Washing	Fixing
Bleaching	Diluting Acetic Acid

EASTMAN SPECIAL SQUEEGEE ..... $ 1.25

KODALOID .005 in., per sq. ft. ..... .30

SPECIAL MECHANICAL REGISTERING BOARD

Supplied by Tri-Chrome Studios: 16 x 20, $60; 11 x14, $40; 8 x 10, $25.

BOARD FOR MOUNTING FINISHED PRINT

Approx. 18 x 24 inches

WHERE YOU CAN HAVE WASH-OFF RELIEF PRINTS MADE FOR YOU

From Kodachrome Transparencies

The Eastman Kodak Co.

Rochester, N. Y.

1 print 5 x 7 ..... $10.00

From separation negatives

Tricolor Print Service, Inc.

323 E. 47th St.

New York City

2 prints 8 x 10	$40
2 prints 11 x 14	50
2 prints 14 x 17	60

From Kodachrome Transparencies

Triak Color Processes

Scientific American Bldg.

24 West 40th Street

New York City

Service through dealers only.

Size	1 print	3 prints
2¼ x 3¼	$ .75	$1.25
3¼ x 4¼	1.50	2.50
4½ x 6½	3.00	4.50
6½ x 8½	6.00	9.00

SOURCES OF MATERIAL

Your local photographic dealers will probably be able to supply you with the materials necessary for this process. If not, you may obtain them from the manufacturers listed with their instruction booklets below. You may also obtain any other information desired from them. By all means procure and study the booklets before commencing work.

The Eastman Kodak Co., Rochester, New York

"Color Printing with the Eastman Wash-Off Relief Process"

The Thomas S. Curtis Labs., 2063-65 E. Gage Avenue, Huntington Park, Calif.

"Curtis Color Printing"

Tri-Chrome Studios, 169 E. Sixth Street, St. Paul, Minn.

"Instructions for Color Printing with Tri-Chrome Dyes"

FORMULAS FOR THE WASH-OFF RELIEF PROCESS

NOTE: Develop negatives for this process soft. A gamma or contrast of about .65 is best.

EASTMAN FORMULAS

DEVELOPER FOR RELIEF FILM DK-50

Water (125°F.)	64 ounces
Elon	145 grains
Sodium Sulphite (desiccated)	4 ounces
Hydroquinone	145 grains
Kodalk	145 grains
Potass. Bromide	29 grains
Cold Water to make	1 gallon

For Wash-Off Relief Film use without dilution and develop 5 minutes at 70°F. Available ready-made in package form.

BLEACH BATH

R-10a

Stock Solution A

Ammonium Bichromate	290 grains
Sulphuric Acid C.P.	1 dram
Water to make	32 ounces

Stock Solution B

Sodium Chloride	1½ ounces
Water to make	32 ounces

For use, take 1 part of A, 1 part of B, and 6 parts of water. In warm weather use ice to keep at 65°F. or below.

FIXING BATH F-5

Water (125°F.)	80 ounces
Hypo	2 pounds
Sodium Sulphite (desiccated)	2 ounces
Acetic Acid (28% pure)	6 ounces
Boric Acid, crystals	1 ounce
Potass. Alum	2 ounces
Cold Water to make	1 gallon

Use Boric Acid crystals. Powder dissolves with great difficulty.

SPECIAL SINGLE BLEACH BATH

Requiring half the time of R-10a Formula

Potass. Bichromate	1 ounce
Potass. Ferricyanide	29 grains
Potass. Bromide	58 grains
Acetic Acid 28%	2¼ ounces
Water	32 ounces

CURTIS FORMULAS

DEVELOPER FOR RELIEF FILM DK-76

Water (125°F.)	64 ounces
Elon	116 grains
Sodium Sulphite (desiccated)	13¼ ounces
Hydroquinone	290 grains
Kodalk	116 grains
Water to make	1 gallon

NOTE: Double the amount of Kodalk given here as called for by regular formula. Normal development—4 minutes at 70°F. If negatives are very soft, use DK-50.

BLEACH BATH

See Eastman Formula

FIXING BATH

Plain Hypo	1 part
Water	9 parts

Throw away after use.

STOCK SOLUTION FOR REGULATING CONTRAST

ACETIC ACID SOLUTION—5%

Glacial Acetic Acid	1 ounce
Water	19 ounces

AMMONIA SOLUTION—10%

Add 1 part of Stronger Ammonia Water to 9 parts of water.

NOTE: Above Acetic Acid and Ammonia Solutions apply to all three methods of processing.

TRI-COLOR FORMULAS

DEVELOPER FOR RELIEF FILM D-11

Water (125°F.)	64 ounces
Elon	60 ounces
Sodium Sulphite (desiccated)	10 ounces
Hydroquinone	1 ounce 88 grains
Carbonate	3 ounces 146 grains
Bromide	292 grains
Cold Water to make	1 gallon

Diluted 1-1 at 65°F. To decrease contrast, dilute up to 1-4. Develop 1½ minutes.

BLEACH BATH

See Eastman Formula

FIXING BATH

See Eastman Formula

PERMANGANATE BATH FOR REMOVING FAINT BROWN STAIN (OPTIONAL) (EASTMAN)

Stock Solution A

Water	32 ounces
Potass. Permanganate	1¾ ounces

Stock Solution B

Water	32 ounces
Sulphuric Acid C.P.	1 ounce

For use: 1 part A, 2 parts B, and 64 parts of water. IMPORTANT: NEVER ADD WATER TO ACID, or solution may boil over causing serious burns on hands or face.

TIME-TABLE—WASH-OFF RELIEF PROCESS

	Eastman	*Curtis*	*Tri-Color*
Make Matched Relief Film Enlargements	1 hour	1 hour	1 hour
Development	15 minutes DK-50	12 minutes DK-76	7½ minutes D-11
	5 minutes each	4 minutes each	2½ minutes each
Short Stop		1 minute	1 minute
Wash in runnng water	10 minutes	5 minutes	5 minutes
Bleach	4 minutes	5 minutes	5 minutes
Develop	6 minutes	6 minutes	6 minutes
Wash in running water	1 minute	1 minute	
Fix	1 minute	2 minutes	3 minutes
Wash in running water	15 minutes	5 minutes	5 minutes
Optional: Permanganate Clearing Bath	1 minute		
Optional: Wash	3 minutes		
Optional: Fix in F-5	1 minute		
Optional: Wash	5 minutes		
Optional: Will make checking exact color balance slightly easier.			
Rinse in Distilled Water	1 minute	5–10 seconds	
Immerse in Formaldehyde	5 minutes		
Dye Images	20 minutes	5–6 minutes	5 minutes
Rinse in Acetic Acid (1 minute each)	3 minutes	3 minutes	3 minutes
Register (5 minutes each)	15 minutes	15 minutes	15 minutes
Transfer	1 hour 20 minutes each	15 minutes 3–7 minutes each	10 minutes 3–4 minutes each
	3 hours, 36 minutes	2 hours, 16 minutes	2 hours, 7 minutes

NOTE: It will be obvious that the total processing time may be decreased by making the enlargements more quickly, if you can do so properly in less time.

PREPARING PAPER FOR TRANSFERRING IMAGES

PREPARATION OF PAPER WITH MORDANTING SOLUTIONS

Imbibition prints may be made on almost any photographic papers except those with a rough surface. The paper is first fixed in a fresh solution of F-5, followed by thorough washing. Then bathe for 5 minutes in the Aluminum Sulphate-Paper Mordanting Solution. Then wash for 5 minutes in running water. Following this it is bathed for 5 minutes in the buffer solution of Sodium Acetate. It is then washed again for 5 minutes. Paper may be used immediately or dried and kept for later use. Before making the imbibition transfer, soak paper thoroughly for 5 minutes in plain water.

MORDANTING SOLUTIONS

A

Aluminum Sulphate	6¾ ounces
Water to make	32 ounces

B

Sodium Carbonate	1 oz. 145 grs.
Water to make	32 ounces

Add B slowly to A, stirring well. A white precipitate is at first formed, but dissolves upon stirring. If a trace remains it can be filtered out with rapid filter paper.

SODIUM ACETATE SOL.—5%

Dissolve Sodium Acetate, Anhydrous, 50 grame in 950 cc. water, or dissolve Sodium Acetate, Anhydrous, 1⅔ ounces in 32 ounces of water.

READY-MADE TRANSFER PAPER

The Eastman Kodak Company manufactures paper already prepared for the transferring of Wash-Off Relief images. Naturally, making use of this will limit one to a single paper surface. It is obtainable in the following sizes at the following prices:

EASTMAN WASH-OFF RELIEF TRANSFER PAPER

5 x 7 per doz.	$ .30
8 x 10 per doz.	.70
11 x 14 per doz.	1.25
14 x 17 per doz.	1.90

WEIGHTS AND MEASURES

Conversion Tables

(In the tables below, some equivalents are approximate rather than exact. The approximations are sufficiently close for all ordinary photographic purposes.)

LIQUID MEASURE

60 minims (drops)	1 dram
8 drams	1 ounce
16 fluid ounces	1 pint
32 fluid ounces	1 quart
64 fluid ounces	½ gallon
128 fluid ounces	1 gallon

CUBIC CENTIMETERS TO FLUID OUNCES

3.70 cc.	1 dram
7.39 cc.	¼ fluid ounce
14.78 cc.	½ fluid ounce
29.57 cc.	1 fluid ounce
59.14 cc.	2 fluid ounces
100 cc.	3⅜ fluid ounces
237 cc.	8 fluid ounces
250 cc.	8½ fluid ounces
473 cc.	16 fluid ounces
500 cc.	17 fluid ounces
946 cc.	32 fluid ounces
1000 cc. (1 liter)	34 fluid ounces

DRY MEASURE
(for quick measuring)

1 ounce	437½ grains
	(or roughly 440 grains)
½ ounce	220 grains
¼ ounce	110 grains
16 ounces	1 pound

GRAMS INTO GRAINS AND OUNCES

1 gram	15.5 grains
2 grams	31 grains
4 grams	62 grains
5 grams	77 grains
10 grams	155 grains
25 grams	387 grains
50 grams	1¾ ounces
100 grams	3½ ounces

GRAINS AND OUNCES INTO GRAMS

1 grain	.065 grams
¼ ounce	7.09 grams
½ ounce	14.17 grams
1 ounce	28.35 grams

NOTE: The Eastman Studio Scale may be obtained for either the Metric or Avoirdupois system of weight.

LINEAR MEASURE

10 millimeters	1 centimeter (or app. 2/5 inch)
100 centimeters	1 meter (or app. 39 inches)
1 inch	25.4 millimeters (or app. 2½ centimeters)

FOR TRAVELING

1 level teaspoon	4 cc.
1 level tablespoon	14.5 cc.
(or about ½ fluid ounce)	
1 ordinary tumbler	8 fluid ounces

Pint and quart milk bottles will serve for greater quantities

A LEVEL TEASPOON HOLDS APPROXIMATELY THE FOLLOWING AMOUNTS OF DRY CHEMICALS:

Metol	60 grains
Kodalk	96 grains
Hydroquinone	60 grains
Bromide	150 grains
Sulphite	130 grains
Carbonate	104 grains

A LEVEL TABLESPOON HOLDS APPROXIMATELY:

Sulphite	1 ounce 80 grains
Carbonate	416 grains

THE LABORATORY

This illustration shows more or less what you will need in order to turn out color prints with any degree of consistency and convenience. The walls are white and all lower parts that are subject to wear are gray. The room is small: 7 ft. 4 in. wide by 8 ft. 3 in. long, and 9 ft. 3 in. high—making it easy to cool with ice in the summer. Although small, this is really a very efficient little laboratory and all the prints in this book were made in it. Beyond, wherein the camera is set up, is another room containing the enlarger, trimmer, densitometer, more sinks, trays for hot water development of Carbros and Wash-Offs, and other equipment for other purposes.

Above are seen wires for hanging prints or celluloids to dry. Blue, red, and yellow images on celluloids are shown hanging. On the top shelf are one-gallon bottles for developers; also three-gallon bottles of those used most, with hoses attached to provide greater convenience in filling graduates. On the shelf below may be seen a five-gallon bottle of distilled water similarly equipped, more bottles of chemicals, the interval timer and second timer clocks; also graduates and a one-gallon funnel.

Below this shelf may be seen a long trough reflector containing a Lumeline light to give even illumination for comparing three wet bromides sticking to the sheet of glass (one of the prints is in the washing tray below). Attached to the washing tray may be seen the Eastman Tray Siphon Washer; behind it a tray kept for swabbing off bromides with acetic acid. To the left of the washer is the deep ten-gallon hypo tray, and above it a wet blue, and a red piece of pigmented paper are hanging to drain. (Normally under these conditions there is a cover over the hypo tray and another tray of cold water set on this in which the sheets of pigmented paper are soaked.) Above the water-jacketed, bromide print developing tray, seen in front of the siphon washer, is the 5 x 7 in. Wratten Safelight, and the shiny long cylinder to the right is the Berkfeld filter.

In the right foreground is the squeegeeing board of white opal glass on which are shown two types of squeegees. In the left foreground, in silhouette, is a V-type wringer (the handle is off, but the gears may be seen). Beyond this, out of sight in the left hand corner of the room, is a plate loading and unloading bench, the negative developing tanks, etc.

Below the 200 watt daylight-blue bulb hanging beneath the metal shade may be seen a long wooden arm projecting from the wall; this arm is excellent for holding wet plate-developing hangers to drain and dry. Towels are on hand at frequent intervals and each is used for only one purpose. From left to right: plate-developing towel, hypo towel (never used for anything else), Carbro towel, etc. Below the tank work bench are seen partitions for storing trays, and shelves for blotters and other apparatus.

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